

APPENDIX 8.1A

## Air Quality

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## **APPENDIX 8.1**

### **AIR QUALITY**

## **APPENDIX 8.1A**

### **EMISSIONS AND OPERATING PARAMETERS**

**Table 8.1A-1**  
**Emissions and Operating Parameters for New Turbines**  
**San Francisco Electric Reliability Project**

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
	36 deg full load, no chilling	59 deg full load, w/chilling	80 deg full load, w/chilling	36 deg 50% load	59 deg 50% load	80 deg 50% load
Ambient Temp, F	36	59	80	36	59	80
GT Load, %	100	100	100	50	50	50
GT heat input, MMBtu/hr (HHV)	484.6	487.3	487.2	273.8	274.0	272.2
Stack flow, lb/hr	1,128,201	1,107,509	1,107,154	745,437	768,865	787,074
Stack flow, dscfm	228,475	222,850	222,710	152,936	158,413	162,980
Stack flow, acfm	619,922	620,308	620,356	412,259	411,857	407,798
Stack temp, F	805	826	826	819	782	744
Stack exhaust, vol %						
O2 (dry)	14.66	14.47	14.46	15.64	15.82	16.00
CO2 (dry)	3.59	3.70	3.70	3.03	2.93	2.83
H2O	10.33	11.18	11.22	8.73	8.16	7.48
Emissions						
NOx, ppmvd @ 15% O2	2.50	2.50	2.50	2.50	2.50	2.50
NOx, lb/hr	4.39	4.41	4.41	2.48	2.48	2.47
NOx, lb/MMBtu	0.0091	0.0090	0.0091	0.0091	0.0091	0.0091
SO2, ppmvd @ 15% O2	0.182	0.182	0.182	0.182	0.182	0.182
SO2, lb/hr	0.45	0.45	0.45	0.25	0.25	0.25
SO2, lb/MMBtu	0.00092	0.00092	0.00092	0.00092	0.00092	0.00092
CO, ppmvd @ 15% O2	4.00	4.00	4.00	4.00	4.00	4.00
CO, lb/hr	4.28	4.30	4.30	2.42	2.42	2.40
CO, lb/MMBtu	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088
VOC, ppmvd @ 15% O2	2.00	2.00	2.00	2.00	2.00	2.00
VOC, lb/hr	1.22	1.23	1.23	0.69	0.69	0.69
VOC, lb/MMBtu	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
PM10, lb/hr	3.0	3.0	3.0	3.0	3.0	3.0
PM10, lb/MMBtu	0.0062	0.0062	0.0062	0.0110	0.0109	0.0110
PM10, gr/dscf	0.00153	0.00157	0.00157	0.00229	0.00221	0.00215
NH3, ppmvd@15% O2	10.0	10.0	10.0	10.0	10.0	10.0
NH3, lb/hr	6.50	6.54	6.53	3.67	3.67	3.65

**Table 8.1A-2**  
**Calculation of Cooling Tower Emissions**  
**San Francisco Electric Reliability Project**

Cooling Tower Design Parameters	
Water Flow Rate, 10E6 lbm/hr	1.96
Water Flow Rate, gal/min	3,912.0
Drift Rate, %	0.0010
Drift, lbm water/hr	19.55
PM10 Emissions based on TDS Level	
TDS level, ppm	2000
PM10, lb/hr (total, two cells)	0.04
PM10, tpy (total, two cells)	0.17

**Table 8.1A-3**  
**Calculation of Annual Fuel Use**  
**San Francisco Electric Reliability Project**

487.3	MMBtu/hr of natural gas per turbine at 36 deg F
1,017	Btu/cf
11,700	MMBtu/day of natural gas per turbine
8,760	hours per year of operation per turbine (equivalent)
4,268,700	MMBtu per year of natural gas per turbine
4,197.4	MMcf per year of natural gas per turbine
12,000	hours per year of operation, total, 3 turbines
5,847,600	MMBtu per year of natural gas total
5,750	MMcf per year of natural gas total

**Table 8.1A-4**  
**Detailed Calculations for Maximum Hourly, Daily and Annual Criteria Pollutant Emissions**  
**San Francisco Electric Reliability Project**

	Base Load			Startup/Shutdown		NOx			SO2	CO			POC		PM10
	max. hour	hrs/day	hrs/yr	hrs/day	hrs/yr	Maximum lb/hr	Ann. Avg. lb/hr	Startup/Shutdown lb/hr (1)	lb/hr	Maximum lb/hr	Ann. Avg. lb/hr	Startup lb/hr	Maximum lb/hr	Startup lb/hr (1)	lb/hr
Each Turbine	1	20	3750	4	250	4.41	4.41	40.0	0.45	4.30	4.30	10.00	1.23	2.00	3.0
	Max lb/hr	NOx Max lb/day	Total tpy	Max lb/hr	SO2 Max lb/day	Total tpy	Max lb/hr	CO Max lb/day	Total tpy	Max lb/hr	POC Max lb/day	Total tpy	Max lb/hr	PM10 Max lb/day	Total tpy
Turbine 1	40.0	248.2	13.3	0.45	10.8	0.9	10.0	126.0	9.3	2.0	32.6	2.6	3.0	72.0	6
Turbine 2	40.0	248.2	13.3	0.45	10.8	0.9	10.0	126.0	9.3	2.0	32.6	2.6	3.0	72.0	6
Turbine 3	40.0	248.2	13.3	0.45	10.8	0.9	10.0	126.0	9.3	2.0	32.6	2.6	3.0	72.0	6
Total, 3 Turbines	120.0	744.6	39.8	1.35	32.3	2.7	30.0	378.0	27.9	6.0	97.8	7.67	9.0	216.0	18.0
Cooling Tower	--	--	--	--	--	--	--	--	--	--	--	--	0.04	0.9	0.2
Facility Total	120.0	744.6	39.8	1.3	32.3	2.7	30.0	378.0	27.9	6.0	97.8	7.7	9.0	216.9	18.2

**Table 8.1A-5**  
**Calculation of Noncriteria Pollutant Emissions from Gas Turbines**  
**San Francisco Electric Reliability Project**

Compound	Emission Factor, lb/MMscf (2)	Maximum Hourly Emissions, lb/hr		Total Annual Emissions, 3 CTGs	
		Each CTG (3)	Total, 3 CTGs	lb/yr	tpy
Ammonia	(5)	6.54	19.62	78,480.0	39.2
Propylene	7.71E-01	0.37	1.11	4,433.3	2.2
Hazardous Air Pollutants					
Acetaldehyde	4.08E-02	1.95E-02	5.86E-02	234.6	0.12
Acrolein	3.69E-03	1.77E-03	5.30E-03	21.2	1.06E-02
Benzene	3.33E-03	1.60E-03	4.79E-03	19.1	9.57E-03
1,3-Butadiene	4.39E-04	2.10E-04	6.31E-04	2.5	1.26E-03
Ethylbenzene	3.26E-02	1.56E-02	4.69E-02	187.5	9.37E-02
Formaldehyde	3.67E-01	0.18	0.53	2,110.3	1.06
Hexane	2.59E-01	0.12	0.37	1,489.3	0.74
Naphthalene	1.66E-03	7.95E-04	2.39E-03	9.5	4.77E-03
PAHs (listed individually below)	1.79E-04	8.58E-05	2.57E-04	1.0	5.15E-04
Anthracene	3.38E-05				
Benzo(a)anthracene	2.26E-05				
Benzo(a)pyrene	1.39E-05				
Benzo(b)fluoranthrene	1.13E-05				
Benzo(k)fluoranthrene	1.10E-05				
Chrysene	2.52E-05				
Dibenz(a,h)anthracene	2.35E-05				
Indeno(1,2,3-cd)pyrene	2.35E-05				
Propylene oxide	2.96E-02	1.42E-02	4.25E-02	170.2	0.09
Toluene	1.33E-01	6.37E-02	0.19	764.8	0.38
Xylene	6.53E-02	3.13E-02	0.09	375.5	0.19
Total HAPs			1.35	5,385.4	2.69

Notes:

- (1) All factors except PAHs, hexane and propylene from AP-42, Table 3.4-1. Acrolein, benzene and formaldehyde reflect oxidation catalyst. Individual PAHs, hexane and propylene are CATEF mean results as AP-42 does not include factors for these compounds.
- (2) Based on maximum hourly turbine fuel use of 487.3 MMBtu/hr and fuel HHV of 1017 Btu/scf. 0.48 MMscf/hr
- (3) Based on total annual fuel use of 5,847,600 MMBtu/yr and fuel HHV of 1017 Btu/scf. 5,750.0 MMscf/yr
- (4) Based on 10 ppm ammonia slip from SCR system.

**Table 8.1A-6**  
**Calculation of Noncriteria Pollutant Emissions from Cooling Tower (1)**  
**San Francisco Electric Reliability Project**

Constituent	Concentration in Cooling Tower Return Water	Emissions, lb/hr	Emissions, lb/day	Emissions, ton/yr	BAAQMD TAC Trigger Level, lb/yr
Ammonia	1 ppb	3.91E-08	9.39E-07	3.43E-04	1.93E+04
Arsenic	10 ppb	3.91E-07	9.39E-06	3.43E-03	2.40E-02
Cadmium	1.5 ppb	5.87E-08	1.41E-06	5.14E-04	4.60E-02
Chromium III (2)	6.5 ppb	2.54E-07	6.10E-06	2.23E-03	n/a
Copper	73 ppb	2.85E-06	6.85E-05	2.50E-02	4.63E+02
Lead	12.5 ppb	4.89E-07	1.17E-05	4.28E-03	2.90E+01
Mercury	0.1 ppb	3.91E-09	9.39E-08	3.43E-05	5.79E+01
Nickel	19.5 ppb	7.63E-07	1.83E-05	6.68E-03	7.30E-01
PAHs	0.8 ppb	3.13E-08	7.51E-07	2.74E-04	4.40E-02
PCBs	0.5 ppb	1.96E-08	4.69E-07	1.71E-04	6.80E-03
Zinc	309 ppb	1.21E-05	2.90E-04	1.06E-01	6.76E+03

Note: (1) Emissions calculated from maximum drift rate of 19.55 lb/hr  
(2) Speciation of water sample indicates that all chromium is in the form of Cr3. Concentration of Cr6+ is non-detectable at the detection level of RL<0.1 micrograms/liter.

APPENDIX 8.1B

## Modeling Analysis

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## **APPENDIX 8.1B**

### **MODELING ANALYSIS**

# POTRERO POWER PLANT 1992 METEOROLOGICAL DATA SET

## 1992 WIND FREQUENCY DISTRIBUTION: ANNUAL

### WIND SPEED AT 10 M HEIGHT (M/S)

SECTOR	WIND SPEED (M/S)											TOTAL
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10+	
N	38.	129.	177.	98.	29.	9.	0.	0.	0.	0.	0.	480.
NNE	25.	121.	184.	69.	13.	6.	4.	0.	0.	0.	0.	422.
NE	24.	132.	74.	14.	10.	1.	3.	1.	0.	0.	0.	259.
ENE	24.	74.	22.	6.	4.	1.	0.	0.	0.	0.	0.	131.
E	25.	94.	32.	5.	3.	1.	0.	0.	0.	0.	0.	160.
ESE	15.	64.	54.	14.	6.	3.	1.	0.	0.	0.	0.	157.
SE	19.	56.	56.	34.	13.	19.	10.	9.	3.	3.	1.	223.
SSE	30.	62.	70.	63.	41.	56.	36.	26.	5.	7.	0.	396.
S	76.	88.	86.	61.	86.	38.	17.	17.	7.	8.	4.	488.
SSW	48.	83.	48.	31.	22.	7.	1.	1.	0.	0.	0.	241.
SW	81.	230.	238.	183.	43.	12.	3.	0.	0.	0.	0.	790.
WSW	103.	352.	831.	614.	321.	87.	11.	0.	0.	0.	0.	2319.
W	84.	229.	368.	292.	205.	102.	38.	8.	0.	0.	0.	1326.
WNW	60.	137.	147.	180.	107.	55.	24.	9.	1.	0.	0.	720.
NW	70.	103.	70.	41.	28.	3.	0.	0.	0.	0.	0.	315.
NNW	44.	87.	126.	66.	26.	7.	1.	0.	0.	0.	0.	357.
TOTAL	766.	2041.	2583.	1771.	957.	407.	149.	71.	16.	18.	5.	8784.
AVERAGE ANNUAL WIND SPEED (M/S) = 2.813												

## 1992 WIND FREQUENCY DISTRIBUTION: FIRST QUARTER

### WIND SPEED AT 10 M HEIGHT (M/S)

SECTOR	WIND SPEED (M/S)											TOTAL
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10+	
N	14.	75.	86.	65.	21.	5.	0.	0.	0.	0.	0.	266.
NNE	16.	57.	130.	54.	6.	3.	2.	0.	0.	0.	0.	268.
NE	15.	56.	48.	8.	5.	1.	0.	1.	0.	0.	0.	134.
ENE	12.	29.	9.	2.	1.	0.	0.	0.	0.	0.	0.	53.
E	13.	23.	8.	1.	0.	0.	0.	0.	0.	0.	0.	45.
ESE	4.	17.	15.	4.	1.	0.	0.	0.	0.	0.	0.	41.
SE	9.	33.	15.	11.	5.	2.	0.	0.	0.	0.	0.	75.
SSE	14.	29.	40.	28.	17.	27.	14.	7.	1.	5.	0.	182.
S	18.	51.	53.	46.	75.	33.	15.	16.	6.	8.	4.	325.
SSW	12.	35.	20.	18.	15.	6.	1.	1.	0.	0.	0.	108.
SW	25.	28.	18.	10.	3.	0.	0.	0.	0.	0.	0.	84.
WSW	17.	33.	31.	9.	6.	1.	0.	0.	0.	0.	0.	97.
W	20.	41.	42.	32.	15.	3.	2.	0.	0.	0.	0.	155.
WNW	15.	45.	29.	29.	16.	9.	1.	1.	0.	0.	0.	145.
NW	29.	23.	23.	20.	16.	3.	0.	0.	0.	0.	0.	114.
NNW	19.	44.	25.	2.	2.	0.	0.	0.	0.	0.	0.	92.
TOTAL	252.	619.	592.	339.	204.	93.	35.	26.	7.	13.	4.	2184.

**1992 WIND FREQUENCY DISTRIBUTION: SECOND QUARTER**  
**WIND SPEED AT 10 M HEIGHT (M/S)**

SECTOR	WIND SPEED (M/S)											TOTAL
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10+	
N	1.	4.	9.	1.	0.	0.	0.	0.	0.	0.	0.	15.
NNE	0.	7.	14.	6.	0.	0.	0.	0.	0.	0.	0.	27.
NE	0.	14.	7.	1.	0.	0.	0.	0.	0.	0.	0.	22.
ENE	3.	13.	3.	0.	0.	0.	0.	0.	0.	0.	0.	19.
E	1.	16.	6.	0.	0.	0.	0.	0.	0.	0.	0.	23.
ESE	3.	20.	15.	3.	0.	0.	0.	0.	0.	0.	0.	41.
SE	1.	7.	13.	5.	0.	0.	3.	2.	1.	0.	0.	32.
SSE	5.	4.	4.	6.	5.	6.	0.	0.	0.	0.	0.	30.
S	6.	10.	11.	6.	4.	5.	0.	0.	0.	0.	0.	42.
SSW	11.	19.	14.	3.	0.	0.	0.	0.	0.	0.	0.	47.
SW	19.	77.	76.	79.	8.	2.	0.	0.	0.	0.	0.	261.
WSW	18.	86.	218.	255.	167.	60.	6.	0.	0.	0.	0.	810.
W	11.	54.	119.	122.	91.	63.	19.	4.	0.	0.	0.	483.
WNW	6.	27.	60.	78.	52.	34.	18.	8.	1.	0.	0.	284.
NW	4.	6.	8.	8.	2.	0.	0.	0.	0.	0.	0.	28.
NNW	1.	2.	8.	2.	3.	3.	1.	0.	0.	0.	0.	20.
TOTAL	90.	366.	585.	575.	332.	173.	47.	14.	2.	0.	0.	2184.

**1992 WIND FREQUENCY DISTRIBUTION: THIRD QUARTER**  
**WIND SPEED AT 10 M HEIGHT (M/S)**

SECTOR	WIND SPEED (M/S)											TOTAL
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10+	
N	9.	2.	3.	2.	0.	0.	0.	0.	0.	0.	0.	16.
NNE	4.	6.	12.	1.	0.	0.	0.	0.	0.	0.	0.	23.
NE	3.	24.	7.	0.	0.	0.	0.	0.	0.	0.	0.	34.
ENE	4.	16.	1.	0.	0.	0.	0.	0.	0.	0.	0.	21.
E	4.	18.	3.	0.	0.	0.	0.	0.	0.	0.	0.	25.
ESE	2.	8.	6.	1.	0.	0.	0.	0.	0.	0.	0.	17.
SE	0.	6.	4.	3.	0.	0.	0.	0.	0.	0.	0.	13.
SSE	1.	6.	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.
S	5.	8.	1.	0.	0.	0.	0.	0.	0.	0.	0.	14.
SSW	7.	11.	5.	0.	0.	0.	0.	0.	0.	0.	0.	23.
SW	9.	69.	104.	71.	17.	1.	0.	0.	0.	0.	0.	271.
WSW	14.	143.	501.	303.	128.	26.	5.	0.	0.	0.	0.	1120.
W	25.	68.	138.	102.	83.	34.	17.	4.	0.	0.	0.	471.
WNW	10.	19.	15.	34.	19.	8.	5.	0.	0.	0.	0.	110.
NW	6.	15.	8.	1.	7.	0.	0.	0.	0.	0.	0.	37.
NNW	4.	0.	2.	0.	0.	0.	0.	0.	0.	0.	0.	6.
TOTAL	107.	419.	810.	518.	254.	69.	27.	4.	0.	0.	0.	2208.

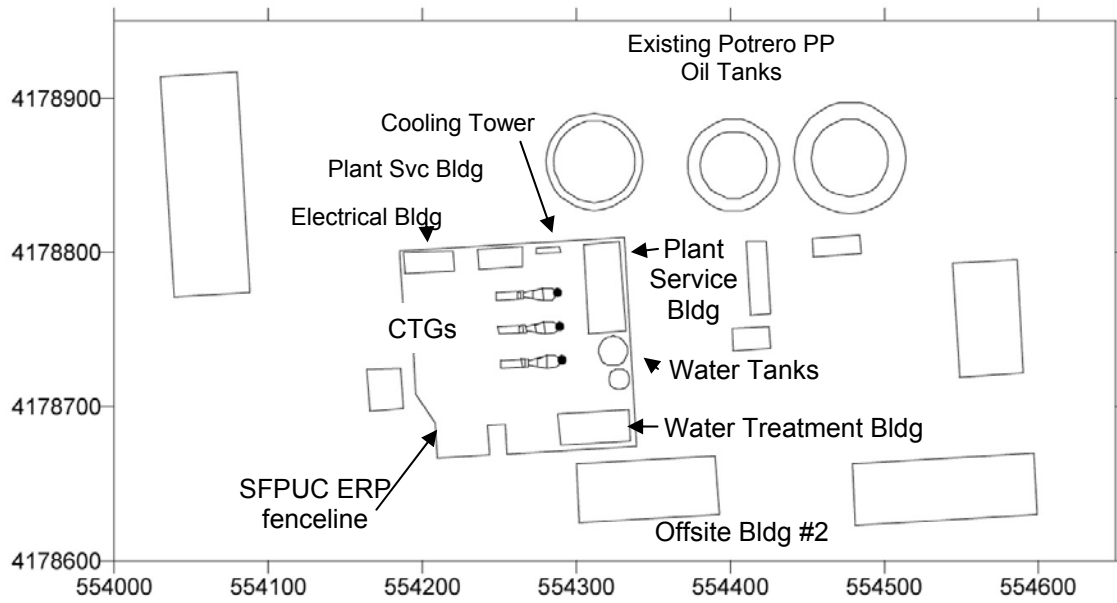
**1992 WIND FREQUENCY DISTRIBUTION: FOURTH QUARTER**  
**WIND SPEED AT 10 M HEIGHT (M/S)**

SECTOR	WIND SPEED (M/S)											TOTAL
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10+	
N	14.	48.	79.	30.	8.	4.	0.	0.	0.	0.	0.	183.
NNE	5.	51.	28.	8.	7.	3.	2.	0.	0.	0.	0.	104.
NE	6.	38.	12.	5.	5.	0.	3.	0.	0.	0.	0.	69.
ENE	5.	16.	9.	4.	3.	1.	0.	0.	0.	0.	0.	38.
E	7.	37.	15.	4.	3.	1.	0.	0.	0.	0.	0.	67.
ESE	6.	19.	18.	6.	5.	3.	1.	0.	0.	0.	0.	58.
SE	9.	10.	24.	15.	8.	17.	7.	7.	2.	3.	1.	103.
SSE	10.	23.	26.	29.	19.	23.	22.	19.	4.	2.	0.	177.
S	47.	19.	21.	9.	7.	0.	2.	1.	1.	0.	0.	107.
SSW	18.	18.	9.	10.	7.	1.	0.	0.	0.	0.	0.	63.
SW	28.	56.	40.	23.	15.	9.	3.	0.	0.	0.	0.	174.
WSW	54.	90.	81.	47.	20.	0.	0.	0.	0.	0.	0.	292.
W	28.	66.	69.	36.	16.	2.	0.	0.	0.	0.	0.	217.
WNW	29.	46.	43.	39.	20.	4.	0.	0.	0.	0.	0.	181.
NW	31.	59.	31.	12.	3.	0.	0.	0.	0.	0.	0.	136.
NNW	20.	41.	91.	62.	21.	4.	0.	0.	0.	0.	0.	239.
TOTAL	317.	637.	596.	339.	167.	72.	40.	27.	7.	5.	1.	2208.

**Table 8.1B-1**  
**Dimensions of On-Site Structures**  
**SFERP**

Feature	Height (feet)	Length (feet)	Width (feet)	Diameter (feet)
CTGs				
Combustion turbines & generators (base unit)	14.5	56.5	13.5	--
Inlet air filters	12	33	37	--
SCR casings	33	60	25	--
CTG stacks	85	--	--	12
Chiller cooling tower	40	50	14	--
Tanks				
DI water storage tank	32	--	--	42
Treated water storage tank	32	--	--	60
Aqueous ammonia storage tank	--	30	--	8
Water treatment building	32	150	64.4	--
Plant service bldg	21	186	75	--
Electrical bldg	21	100	42	--
Admin/control bldg	28	92	44	--

Figure 8.1B-1  
Building Layout for GEP Analysis



**Table 8.1B-2**  
**Emissions and Stack Parameters for Screening Modeling**  
**SFPUC ERP**

Turbine Case	Turbine Load, %	Ambient Temp (deg F)	Ambient Temp (deg K)	Stack Diam (m)	Stack Height (m)	Exhaust Temp (deg K)	Exhaust Velocity (m/s)
1	100	36	275.22	3.658	25.908	702.444	27.845
2	100	59	288.00	3.658	25.908	714.111	27.862
3	100	80	299.67	3.658	25.908	714.111	27.865
4	50	36	275.22	3.658	25.908	710.222	18.517
5	50	59	288.00	3.658	25.908	689.667	18.499
6	50	80	299.67	3.658	25.908	668.556	18.317

Note: Parameters are for each turbine.

**Table 8.1B-3**  
**Results of the Unit Impact and Turbine Screening Analysis**  
**San Francisco Electric Reliability Project**

Turbine Case	Modeled Unit Impact, ug/m3 per 3.0 g/s				
	1-hr	3-hr	8-hr	24-hr	annual
1992 Met Data					
1	15.021	8.360	4.794	1.902	0.249
2	14.850	8.289	4.755	1.886	0.246
3	14.849	8.288	4.754	1.886	0.246
4	21.765	10.696	6.447	2.433	0.343
5	22.152	10.829	6.539	2.463	0.348
6	22.754	10.029	6.680	2.508	0.358

Emission Rates by Pollutant and Averaging Period Modeling (lb/hr)												
Turbine Case	NOx			SO2				CO			PM10	
	1-hr	Startup	Annual avg	1-hr	3-hr	24-hr	Annual avg	1-hr	Startup	8-hr	24-hr	Annual avg
1	4.39	--	3.02	0.45	0.45	0.45	0.20	4.28	--	7.14	3.00	1.37
2	4.41	--	3.03	0.45	0.45	0.45	0.20	4.30	--	7.15	3.00	1.37
3	4.41	--	3.03	0.45	0.45	0.45	0.20	4.30	--	7.15	3.00	1.37
4	2.48	40	2.20	0.25	0.25	0.25	0.11	2.42	10	6.21	3.00	1.37
5	2.48	40	2.20	0.25	0.25	0.25	0.12	2.42	10	6.21	3.00	1.37
6	2.47	40	2.20	0.25	0.25	0.25	0.11	2.40	10	6.20	3.00	1.37

Emission Rates by Pollutant and Averaging Period Modeling (g/s)												
Turbine Case	NOx			SO2				CO			PM10	
	1-hr	Startup	annual avg	1-hr	3-hr	24-hr	annual avg	1-hr	Startup	8-hr	24-hr	annual avg
1	0.553	--	0.381	0.056	0.056	0.056	0.026	0.539	--	0.900	0.378	0.173
2	0.556	--	0.382	0.057	0.057	0.057	0.026	0.542	--	0.901	0.378	0.173
3	0.556	--	0.382	0.056	0.056	0.056	0.026	0.542	--	0.901	0.378	0.173
4	0.312	5.04	0.278	0.032	0.032	0.032	0.014	0.305	1.26	0.782	0.378	0.173
5	0.312	5.04	0.278	0.032	0.032	0.032	0.015	0.305	1.26	0.782	0.378	0.173
6	0.311	5.04	0.277	0.032	0.032	0.032	0.014	0.302	1.26	0.781	0.378	0.173

Turbine Case	Load/ Ambient Temp	Modeled Impacts for Three CTGs, ug/m3, by Pollutant and Averaging Period											
		NOx			SO2				CO			PM10	
		1-hr	Startup	Annual	1-hr	3-hr	24-hr	Annual	1-hr	Startup	8-hr	24-hr	Annual
1	100% 36 deg	8.31	--	0.095	0.844	0.469	0.1068	0.00639	8.10	--	4.31	0.72	0.043
2	100% 59 deg w/ chilling	8.25	--	0.094	0.839	0.468	0.1066	0.00636	8.05	--	4.28	0.71	0.043
3	100% 80 deg w/ chilling	8.25	--	0.094	0.838	0.468	0.1065	0.00635	8.04	--	4.28	0.71	0.043
4	50% 36 deg	6.80	109.70	0.095	0.69	0.34	0.077	0.005	6.64	27.42	5.04	0.92	0.059
5	50% 59 deg	6.92	111.65	0.097	0.70	0.34	0.078	0.005	6.75	27.91	5.12	0.93	0.060
6	50% 80 deg	7.08	114.68	0.099	0.72	0.32	0.080	0.005	6.88	28.67	5.22	0.95	0.062

**Table 8.1B-4**  
**Emission Rates and Stack Parameters for Refined Modeling**  
**San Francisco Electric Reliability Project**

	Stack Diam, m	Stack Height, m	Exh Temp, Deg K	Exhaust Flow, m3/s	Exhaust Velocity, m/s	Emission Rate, g/s			
						NOx	SO2	CO	PM10
Averaging Period: 24 hours, PM10									
Each Turbine	3.658	25.908	668.56	192.46	18.317	n/a	n/a	n/a	3.78E-01
Cooling Towers (each cell)	3.962	12.764	294.11	101.45	8.227	n/a	n/a	n/a	2.46E-03
Averaging Period: Annual, PM10									
Each Turbine	3.658	25.908	668.56	192.46	18.317	n/a	n/a	n/a	3.78E-01
Cooling Towers (each cell)	3.962	12.764	294.11	101.45	8.227	n/a	n/a	n/a	2.46E-03

**Table 8.1B-5**
**Analysis of Impacts due to Inversion Breakup Fumigation  
San Francisco Electric Reliability Project**
**CTG Emission Rates, g/s**

	NOx	CO	PM10	SO2
Case 1	0.553	0.539	0.378	0.0562
Case 2	0.556	0.542	0.378	0.0565
Case 3	0.556	0.542	0.378	0.0565
Case 4	0.312	0.305	0.378	0.0317
Case 5	0.312	0.305	0.378	0.0318
Case 6	0.311	0.302	0.378	0.0316

**Inversion Breakup Modeling Results from SCREEN3**

	Unit Impacts, ug/m3 per g/s	Maximum One-Hour Avg Impacts, ug/m3				Distance to Maximum (m)
		NOx	CO	PM10	SO2	
Case 1	0.9943	0.5500	0.5362	0.3758	0.0558	19,058
Case 2	0.9858	0.5478	0.5341	0.3726	0.0557	19,178
Case 3	0.9857	0.5477	0.5341	0.3726	0.0557	19,179
Case 4	1.313	0.4103	0.4004	0.4963	0.0416	15,545
Case 5	1.333	0.4165	0.4065	0.5039	0.0423	15,373
Case 6	1.364	0.4245	0.4125	0.5156	0.0431	15,117

**Flat Terrain Modeling Results from SCREEN3**

	Unit Impacts, ug/m3 per g/s	Maximum One-Hour Avg Impacts, ug/m3				Distance to Maximum (m)
		NOx	CO	PM10	SO2	
Case 1	0.6965	0.3853	0.3756	0.2633	0.0391	1201
Case 2	0.6886	0.3826	0.3731	0.2603	0.0389	1205
Case 3	0.6885	0.3826	0.3730	0.2603	0.0389	1205
Case 4	1.006	0.3144	0.3067	0.3803	0.0319	1074
Case 5	1.014	0.3169	0.3092	0.3833	0.0322	1072
Case 6	1.018	0.3168	0.3078	0.3848	0.0321	1072

**Adjust unit impacts for longer averaging periods to account for 90-minute duration of  
fumigation**

	1-hr unit	3-hr unit	8-hr unit	24-hr unit
Case 1	0.9943	0.8454	0.7523	0.7151
Case 2	0.9858	0.8372	0.7443	0.7072
Case 3	0.9857	0.8371	0.7442	0.7071
Case 4	1.3130	1.1595	1.0636	1.0252
Case 5	1.3330	1.1735	1.0738	1.0339
Case 6	1.3640	1.1910	1.0829	1.0396

**Table 8.1B-5 (cont'd)****Calculation of Fumigation Impacts for Three Units**

Case/Avg Period	NOx	CO	PM10	SO2
One-Hour				
Case 1	1.6500	1.6086	-	0.1675
Case 2	1.6433	1.6023	-	0.1671
Case 3	1.6431	1.6022	-	0.1670
Case 4	1.2309	1.2011	-	0.1249
Case 5	1.2496	1.2194	-	0.1270
Case 6	1.2735	1.2374	-	0.1292
3 Hours				
Case 1	-	-	-	0.1282
Case 2	-	-	-	0.1504
Case 3	-	-	-	0.1503
Case 4	-	-	-	0.1124
Case 5	-	-	-	0.1143
Case 6	-	-	-	0.1162
8 Hours				
Case 1	-	0.8520	-	-
Case 2	-	0.8469	-	-
Case 3	-	0.8468	-	-
Case 4	-	0.6810	-	-
Case 5	-	0.6876	-	-
Case 6	-	0.6877	-	-
24 Hours				
Case 1	-	-	0.3244	0.0482
Case 2	-	-	0.3208	0.0480
Case 3	-	-	0.3207	0.0479
Case 4	-	-	0.4650	0.0390
Case 5	-	-	0.4690	0.0394
Case 6	-	-	0.4716	0.0394

## NOTES TO TABLE 8.1B-5

### INVERSION BREAKUP FUMIGATION ANALYSIS

Inversion breakup fumigation is generally a short-term phenomenon and was evaluated here as persisting for up to 90 minutes. SCREEN3 was used to model one-hour unit impacts from the turbines under 2.5 m/s winds and F stability (for fumigation impacts) and under all meteorological conditions (shown in the table as “Inversion Breakup Modeling Results from SCREEN3”).

For longer-term averaging periods, impacts were calculated using the highest modeled impact from SCREEN3 for the corresponding averaging period. A sample calculation for 24-hour average PM<sub>10</sub> for Case 1 is as follows:

- For a single turbine, Case 1, 1-hour average unit impact = 0.9943 ug/m<sup>3</sup> per g/s
- For a single turbine, Case 1, max. 1-hour average unit impact from SCREEN3 = 0.6965 ug/m<sup>3</sup> per g/s
- For a single turbine, the appropriate unit impact for the 24-hour averaging period is calculated as 1.5 hours of inversion breakup fumigation plus 22.5 hours of operation under typical conditions (from SCREEN3):  $[(1.5 * 0.9943 \text{ ug/m}^3 \text{ per g/s}) + (22.5 * 0.6965 \text{ ug/m}^3 \text{ per g/s})] \div 24 \text{ hrs} = 0.7151 \text{ ug/m}^3 \text{ per g/s}$
- For three turbines with an emission rate of 0.378 g/s, the total 24-hour average PM<sub>10</sub> impact under inversion breakup fumigation conditions is:  $0.7151 \text{ ug/m}^3 \text{ per g/s} * 0.378 \text{ g/s per turbine} * 0.4 [\text{persistence factor for converting 1-hour average screening impact into 24-hour average concentration}] * 3 \text{ turbines} = 0.3244 \text{ ug/m}^3$

**Table 8.1B-6**  
**Analysis of Impacts due to Shoreline Fumigation**  
**San Francisco Electric Reliability Project**

**CTG Emission Rates, g/s**

	NOx	CO	PM10	SO2
Case 1	0.553	0.539	0.378	0.056
Case 2	0.556	0.542	0.378	0.057
Case 3	0.556	0.542	0.378	0.056
Case 4	0.312	0.305	0.378	0.032
Case 5	0.312	0.305	0.378	0.032
Case 6	0.311	0.302	0.378	0.032

**Shoreline Fumigation Modeling Results from SCREEN3**

	Unit Impacts, ug/m3 per g/s	Maximum One-Hour Avg Impacts, ug/m3				Distance to Maximum (m)
		NOx	CO	PM10	SO2	
Case 1	6.358	3.5169	3.4287	2.4033	0.3571	1837
Case 2	6.299	3.5001	3.4128	2.3810	0.3560	1852
Case 3	6.298	3.4995	3.4123	2.3806	0.3556	1852
Case 4	8.602	2.6880	2.6229	3.2516	0.2728	1409
Case 5	8.745	2.7326	2.6665	3.3056	0.2778	1389
Case 6	8.966	2.7904	2.7113	3.3891	0.2830	1358

**Flat Terrain Modeling Results from SCREEN3**

	Unit Impacts, ug/m3 per g/s	Maximum One-Hour Avg Impacts, ug/m3				Distance to Maximum (m)
		NOx	CO	PM10	SO2	
Case 1	0.6965	0.3853	0.3756	0.2633	0.0391	1201
Case 2	0.6886	0.3826	0.3731	0.2603	0.0389	1205
Case 3	0.6885	0.3826	0.3730	0.2603	0.0389	1205
Case 4	1.006	0.3144	0.3067	0.3803	0.0319	1074
Case 5	1.014	0.3169	0.3092	0.3833	0.0322	1072
Case 6	1.018	0.3168	0.3078	0.3848	0.0321	1072

**Adjust unit impacts for longer averaging periods to account for three-hour duration of fumigation**

	1-hr unit	3-hr unit	8-hr unit	24-hr unit
Case 1	6.3580	6.3580	2.8196	1.4042
Case 2	6.2990	6.2990	2.7925	1.3899
Case 3	6.2980	6.2980	2.7921	1.3897
Case 4	8.6020	8.6020	3.8545	1.9555
Case 5	8.7450	8.7450	3.9131	1.9804
Case 6	8.9660	8.9660	3.9985	2.0115

**Table 8.1B-6 (cont'd)**

**Calculation of Shoreline Fumigation Impacts for Three Units**

Case/Avg Period	NOx	CO	PM10	SO2
<b>One-Hour</b>				
Case 1	10.55	10.29	-	1.07
Case 2	10.50	10.24	-	1.07
Case 3	10.50	10.24	-	1.07
Case 4	8.06	7.87	-	0.82
Case 5	8.20	8.00	-	0.83
Case 6	8.37	8.13	-	0.85
<b>3 Hours</b>				
Case 1	-	-	-	0.964
Case 2	-	-	-	0.961
Case 3	-	-	-	0.960
Case 4	-	-	-	0.737
Case 5	-	-	-	0.750
Case 6	-	-	-	0.764
<b>8 Hours</b>				
Case 1	-	3.19	-	-
Case 2	-	3.18	-	-
Case 3	-	3.18	-	-
Case 4	-	2.47	-	-
Case 5	-	2.51	-	-
Case 6	-	2.54	-	-
<b>24 Hours</b>				
Case 1	-	-	0.637	0.095
Case 2	-	-	0.630	0.094
Case 3	-	-	0.630	0.094
Case 4	-	-	0.887	0.074
Case 5	-	-	0.898	0.075
Case 6	-	-	0.912	0.076

## NOTES TO TABLE 8.1B-6

### SHORELINE FUMIGATION ANALYSIS

Shoreline fumigation was modeled for the turbines using SCREEN3 TIBL factors ranging from 2 to 6 at a distance to shoreline of 2000 meters. The turbines were found to have the highest impacts with a TIBL factor of 3; at TIBL factors greater than 3, the plume height was found to remain below the TIBL height.

Based on the analysis of wind persistence in the meteorological data set that was performed by URS for the Potrero 7 project at the same location, shoreline fumigation conditions were assumed to persist for up to 3 hours. For longer-term averaging periods, impacts were calculated using the highest modeled impact from SCREEN3 for the corresponding averaging period. A sample calculation for 24-hour average  $PM_{10}$  for Case 3 is as follows:

- For a single turbine, Case 1, 1-hour average unit impact = 6.358 ug/m<sup>3</sup> per g/s
- For a single turbine, Case 1, max. 1-hour average unit impact from SCREEN3 = 0.6965 ug/m<sup>3</sup> per g/s
- For a single turbine, 24-hour unit impact is calculated as 3 hours of shoreline fumigation plus 21 hours of operation under typical conditions (from SCREEN3):  $[(3 * 6.358 \text{ ug/m}^3 \text{ per g/s}) + (21 * 0.6965 \text{ ug/m}^3 \text{ per g/s})] \div 24 \text{ hrs} = 1.4042 \text{ ug/m}^3 \text{ per g/s}$
- For three turbines with an emission rate of 0.378 g/s, the total 24-hour average  $PM_{10}$  impact under shoreline fumigation conditions is:  $1.4042 \text{ ug/m}^3 \text{ per g/s} * 0.378 \text{ g/s per turbine} * 0.4 \text{ [persistence factor for converting 1-hour average screening impact into 24-hour average concentration]} * 3 \text{ turbines} = 0.637 \text{ ug/m}^3$

**Table 8.1B-7**  
**Gas Turbine Commissioning Profile**  
**San Francisco Electric Reliability Project**

Operating Mode	Hours of Operation(1)	Fuel Use MMBtu/hr (2) (HHV)	Emission Factors (lbs/MMBtu)					Hourly Emissions (lbs/hr)			
			NOx(3)	CO(4)	VOC(5)	PM10(6)	SOx(7)	NOx	CO	VOC	PM10
Turbine 1 - FSNL	4	96.9	0.3640	0.2650	0.0755	n/a	0.00092	35.28	25.68	7.32	3.0
Turbine 2 - FSNL	4	96.9	0.3640	0.2650	0.0755	n/a	0.00092	35.28	25.68	7.32	3.0
Turbine 3 - FSNL	4	96.9	0.3640	0.2650	0.0755	n/a	0.00092	35.28	25.68	7.32	3.0
Turbine 1 - Min. Load, no SCR or ox cat	20	96.9	0.15288	0.1501	0.0201	n/a	0.00092	14.82	14.55	1.95	3.0
Turbine 2 - Min. Load, no SCR or ox cat	20	96.9	0.15288	0.1501	0.0201	n/a	0.00092	14.82	14.55	1.95	3.0
Turbine 3 - Min. Load, no SCR or ox cat	20	96.9	0.15288	0.1501	0.0201	n/a	0.00092	14.82	14.55	1.95	3.0
Turbine 1 - FSNL (if necessary)	24	96.9	0.3640	0.2650	0.0755	n/a	0.00092	35.28	25.68	7.32	3.0
Turbine 2 - FSNL (if necessary)	24	96.9	0.3640	0.2650	0.0755	n/a	0.00092	35.28	25.68	7.32	3.0
Turbine 3 - FSNL (if necessary)	24	96.9	0.3640	0.2650	0.0755	n/a	0.00092	35.28	25.68	7.32	3.0
Turbine 1 - Multiple Load - Full SCR/ox cat	48	487.3	0.05915	0.0088	0.0025	n/a	0.00092	28.82	4.30	1.23	3.0
Turbine 2 - Multiple Load - Full SCR/ox cat	48	487.3	0.05915	0.0088	0.0025	n/a	0.00092	28.82	4.30	1.23	3.0
Turbine 3 - Multiple Load - Full SCR/ox cat	48	487.3	0.05915	0.0088	0.0025	n/a	0.00092	28.82	4.30	1.23	3.0

Total = 288

Notes:

(1) Hours of Operation - based on information supplied by MID for the MEGS project.

(2) Fuel Use

- No Load test: Based on 20% of maximum heat input rating.
- Minimum Load test: Based on 20% of maximum heat input rating.
- Multiple Load test: Based on 100% of maximum heat input rating.

(3) NOx Emission Factors

- No Load test: Based on 100 ppm @ 15% O2.
- Minimum Load test: Based on maximum uncontrolled emission rate of 42 ppm @ 15% O2.
- Multiple Load Full SCR/ox cat test: Based on NOx emission levels at the midway point between 30 ppm and 2.5 ppm @ 15% O2.

(4) CO Emission Factors

- No Load test: Based on maximum uncontrolled emission rate of 30 times controlled level, or 120 ppm @ 15% O2.
- Minimum Load test: Based on maximum uncontrolled emission rate of 17 times controlled level, or 68 ppm @ 15% O2.
- Multiple Load Full SCR/ox cat test: Based on unit meeting the project design level of 4 ppm @ 15% O2 with oxidation catalyst installed and operating.

(5) VOC Emission Factors

- No Load test: Based on maximum uncontrolled emission rate of 30 times controlled level, or 60 ppm @ 15% O2.
- Minimum Load test: Based on maximum uncontrolled emission rate of 8 times controlled level, or 16 ppm @ 15% O2.
- Multiple Load Full SCR/ox cat test: Based on unit meeting the project design level of 2 ppm @ 15% O2 with oxidation catalyst installed and operating.

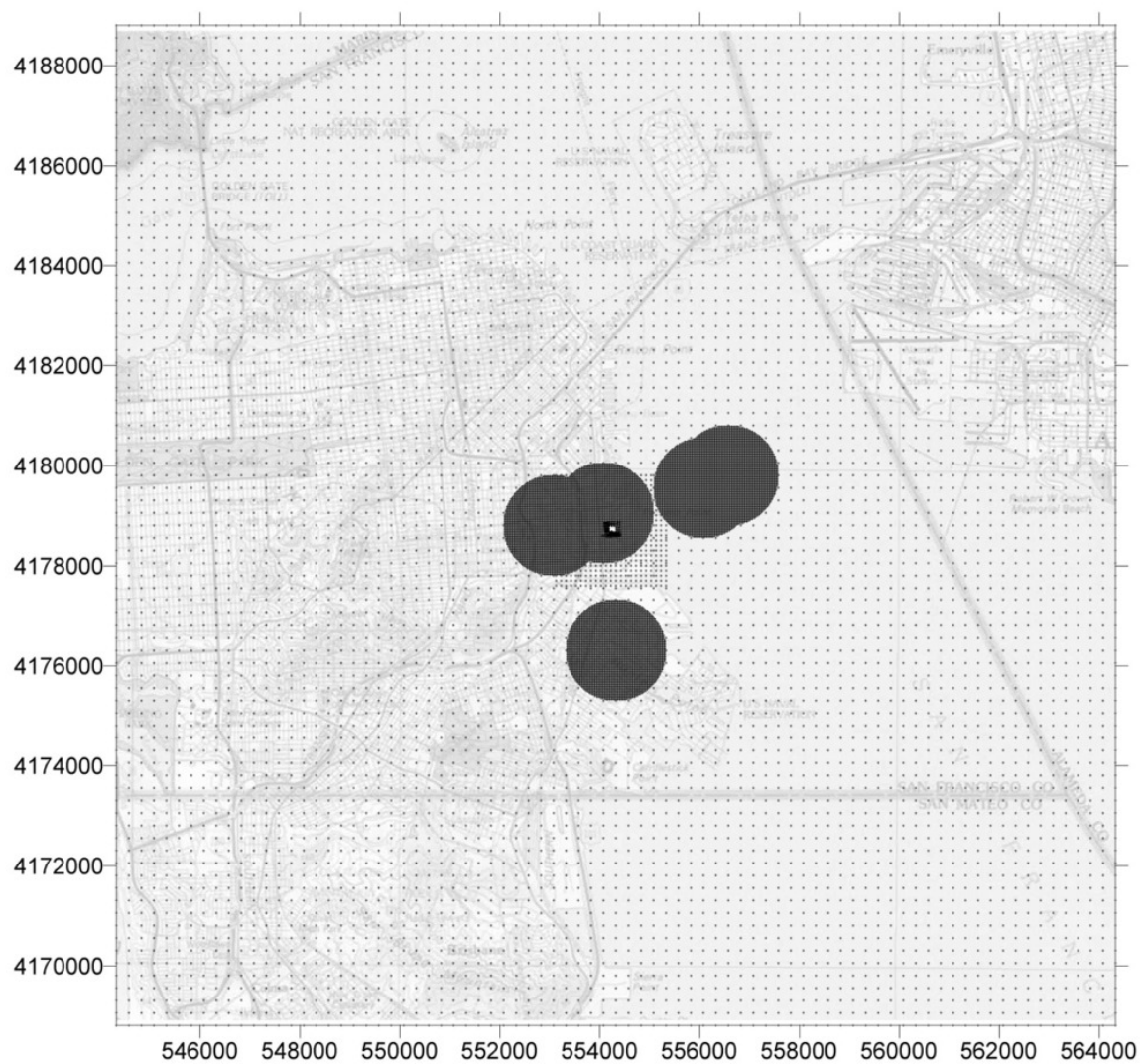
(6) PM10 Emission Factors

- For all tests, based on project design PM10 level of 3.0 lbs/hr.

(7) SOx Emission Factors

- For all tests, based on annual average natural gas sulfur content of 0.33 gr/100 scf.

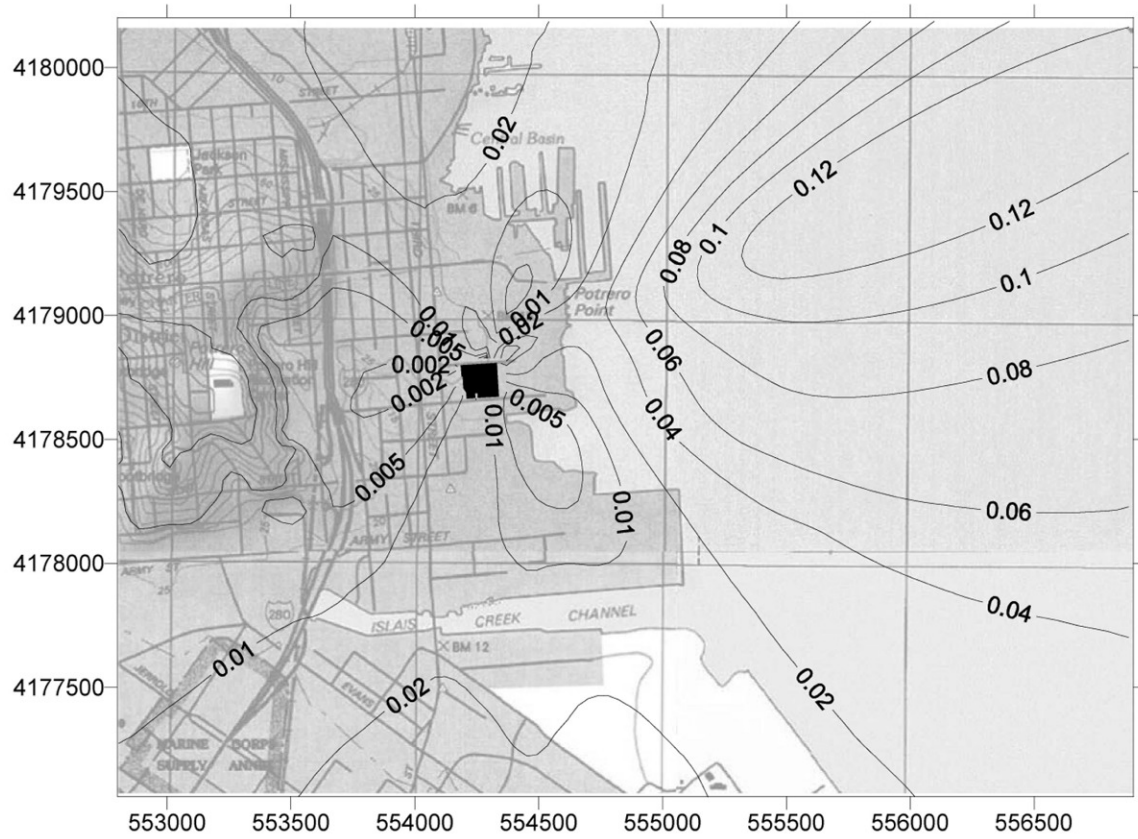
**Figure 8.1B-2**  
**Layout of the Receptor Grids**





**Figure 8.1B-4**

**Maximum Annual Average PM<sub>10</sub> Impacts During Project Operation**



APPENDIX 8.1C

## Screening Health Risk Assessment

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## **APPENDIX 8.1C**

### **SCREENING HEALTH RISK ASSESSMENT**

**Table 8.1C-1****Calculation of Maximum Impacts of Hazardous Air Pollutants  
San Francisco Electric Reliability Project**

Turbine Case	Max. 1-hr Impact, ug/m3 per 3.0 g/s	Max. Annual Impact, ug/m3 per 3.0 g/s	Heat Input, MMBtu/hr	Product, 1-hr avg	Product, annual avg
1	15.0208	0.2492	484.6	7279.1	120.76
2	14.8501	0.2464	487.3	7236.5	120.07
3	14.8485	0.2463	487.2	7234.2	120.00
4	21.7654	0.3431	273.8	5959.4	93.9
5	22.1523	0.3483	274.0	6069.7	95.4
6	22.754	0.3582	272.2	6193.6	97.5

As emissions of HAPs from the CTGs are directly related to heat input, operating case with highest product of heat input and unit impact will have highest HAP impacts.

Thus Case 1 will be worst case for all impacts.

Compound (1)	Emission Rates for Modeling, g/s (per CTG)		Modeled Impacts, ug/m3 (total, three CTGs)	
	1-hr avg basis	annual avg basis	1-hr avg basis	annual avg basis
<u>CTGs</u>				
Ammonia	0.824	0.376	12.378	9.38E-02
Propylene	0.047	2.13E-02	0.699	5.30E-03
Acetaldehyde	2.46E-03	1.12E-03	3.70E-02	2.80E-04
Acrolein	2.23E-04	1.02E-04	3.35E-03	2.54E-05
Benzene	2.01E-04	9.18E-05	3.02E-03	2.29E-05
1,3-Butadiene	2.65E-05	1.21E-05	3.98E-04	3.02E-06
Ethylbenzene	1.97E-03	8.99E-04	2.96E-02	2.24E-04
Formaldehyde	2.22E-02	1.01E-02	3.33E-01	2.52E-03
Hexane	1.56E-02	7.14E-03	2.35E-01	1.78E-03
Naphthalene	1.00E-04	4.58E-05	1.51E-03	1.14E-05
PAHs	1.08E-05	4.93E-06	1.62E-04	1.23E-06
Propylene oxide	1.79E-03	8.16E-04	2.68E-02	2.03E-04
Toluene	8.03E-03	3.67E-03	0.121	9.14E-04
Xylene	3.94E-03	1.80E-03	5.92E-02	4.49E-04

Notes:

(1) CTG factors from Table 8.1A-5.

**Table 8.1C-2**  
**Acute Inhalation Hazard Index**  
**San Francisco Electric Reliability Project**

Pollutant Name	1-hr Conc, ug/m3	Acute REL, ug/m3 (1)	Toxicological Endpoints	Inhalation Hazard Index
Acrolein	3.35E-03	1.90E-01	Eye irritation	1.76E-02
Ammonia	1.24E+01	3.20E+03	Eye and respiratory irritation	3.87E-03
Benzene	3.02E-03	1.30E+03	Reproductive/ Developmental	2.32E-06
Formaldehyde	3.33E-01	9.40E+01	Eye irritation	3.54E-03
Propylene oxide	2.68E-02	3.10E+03	Eye and respiratory irritation	8.66E-06
Toluene	1.21E-01	3.70E+04	CNS (mild); Eye and respiratory irritation	3.26E-06
Xylenes	5.92E-02	2.20E+04	Eye and respiratory irritation	2.69E-06
<b>Total Acute Hazard Index</b>				<b>0.0250</b>

**Table 8.1C-3**  
**Chronic Inhalation Hazard Index**  
**San Francisco Electric Reliability Project**

	Pathway (1)							
	Resp	CV/BL	CNS	Skin	Repro	Kidn	GI/LV	Immun
<b>Total Chronic</b>	0.0018	<.0001	<.0001	0.0013	<.0001	<.0001	<.0001	--

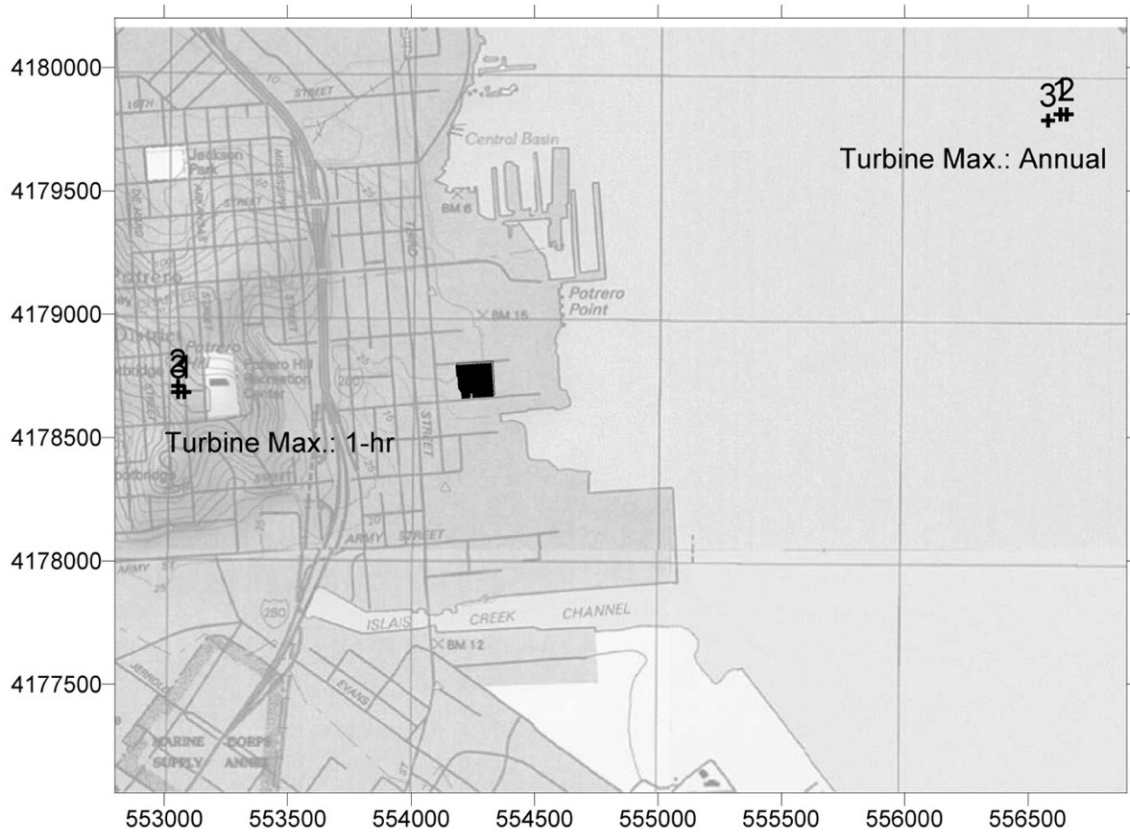
Notes:

(1) Resp: respiratory; CV/BL: cardiovascular/blood; CNS: central nervous system; Repro: reproductive system;  
 Kidn: renal system; GI/LV: gastrointestinal/liver; Immun: immunological system

**Table 8.1C-4**  
**Individual Cancer Risk**  
**San Francisco Electric Reliability Project**

	Air	Soil	Skin	Garden	Mmilk	Other
CTGs	1.92E-08	2.03E-09	1.29E-09	0.00E+00	0.00E+00	0.00E+00
<b>TOTAL RISK</b>	<b>0.023 in one million</b>					

**Figure 8.1C-1**  
**Locations of Top Three Acute, Chronic and Cancer Risks**



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ACUTE INHALATION EXPOSURE REPORT

Run Made By  
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Sierra Research

Project : SFPUC ERP

Feb. 18, 2004

Pollutant Database Date : Nov. 15, 2000  
Database Reference..... : CAPCOA Risk Assessment Guidelines

-----  
DILUTION FACTOR FOR POINT UNDER EVALUATION

X/Q (ug/m3)/(g/s) : 1.00E+00  
-----

MAX. 1-HR EMISSION RATE INFORMATION

File: 1HRAVG.M96

Pollutant Name	Emission Rate (g/s)
----------------	---------------------

ACROLEIN	3.350E-03
AMMONIA	1.238E+01
BENZENE	3.020E-03
FORMALDEHYDE	3.330E-01
PROPYLENE OXIDE	2.680E-02
TOLUENE	1.210E-01
XYLENES	5.920E-02

-----

ACUTE INHALATION HAZARD INDEX

Pollutant	Resp	CV/BL	CNS	Eye	Repro	Kidn	GI/LV	Immun
ACROLEIN	0.0176	--	--	0.0176	--	--	--	--
AMMONIA	0.0039	--	--	0.0039	--	--	--	--
BENZENE	--	<.0001	--	--	<.0001	--	--	<.0001
FORMALDEHYDE	0.0035	--	--	0.0035	--	--	--	0.0035
PROPYLENE OXIDE	<.0001	--	--	<.0001	<.0001	--	--	--
TOLUENE	<.0001	--	<.0001	<.0001	<.0001	--	--	--
XYLENES	<.0001	--	--	<.0001	--	--	--	--
Total Acute	0.0251	<.0001	<.0001	0.0251	<.0001	--	--	0.0035

A Zero Background Concentration file was used to perform this analysis, therefore, there is no contribution from background pollutants.

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CHRONIC INHALATION EXPOSURE REPORT

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Project : SFPUC ERP

Feb. 18, 2004

Pollutant Database Date : Nov. 15, 2000  
Database Reference..... : CAPCOA Risk Assessment Guidelines

---

DILUTION FACTOR FOR POINT UNDER EVALUATION

X/Q (ug/m3)/(g/s) : 1.00E+00

---

ANNUAL AVERAGE EMISSION RATE INFORMATION

File: ANNAVG.E96

Pollutant Name	Emission Rate (g/s)
1,3-BUTADIENE	3.020E-06
ACETALDEHYDE	2.800E-04
ACROLEIN	2.540E-05
AMMONIA	9.380E-02
BENZENE	2.290E-05
ETHYL BENZENE	2.240E-04
FORMALDEHYDE	2.520E-03
N-HEXANE	1.780E-03
NAPHTHALENE	1.140E-05
PAH:BENZO (A) PYRENE	1.230E-06
PROPYLENE (PROPENE)	5.300E-03
PROPYLENE OXIDE	2.030E-04
TOLUENE	9.140E-04
XYLENES	4.490E-04

---

CHRONIC INHALATION HAZARD INDEX

Pollutant	Resp	CV/BL	CNS	Skin	Repro	Kidn	GI/LV	Immun
1,3-BUTADIENE	--	--	--	--	<.0001	--	--	--
ACETALDEHYDE	<.0001	--	--	--	--	--	--	--
ACROLEIN	0.0004	--	--	0.0004	--	--	--	--
AMMONIA	0.0005	--	--	--	--	--	--	--
BENZENE	--	<.0001	<.0001	--	<.0001	--	--	--
ETHYL BENZENE	--	--	--	--	<.0001	<.0001	<.0001	--
FORMALDEHYDE	0.0008	--	--	0.0008	--	--	--	--
N-HEXANE	--	--	<.0001	--	--	--	--	--
NAPHTHALENE	<.0001	--	--	--	--	--	--	--
PROPYLENE (PROP	<.0001	--	--	--	--	--	--	--
PROPYLENE OXIDE	<.0001	--	--	--	--	--	--	--
TOLUENE	<.0001	--	<.0001	--	<.0001	--	--	--
XYLENES	<.0001	--	<.0001	--	--	--	--	--
Total Chronic	0.0018	<.0001	<.0001	0.0013	<.0001	<.0001	<.0001	--

A Zero Background Concentration file was used

to perform this analysis, therefore, there is  
no contribution from background pollutants.

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Health Risk Assessment Program  
Version 2.0e

CHRONIC NONINHALATION EXPOSURE REPORT

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Project : SFPUC ERP

Feb. 18, 2004

Pollutant Database Date : Nov. 15, 2000  
Database Reference..... : CAPCOA Risk Assessment Guidelines

---

DILUTION FACTOR FOR POINT UNDER EVALUATION

X/Q (ug/m3)/(g/s) : 1.00E+00

---

ANNUAL AVERAGE EMISSION RATE INFORMATION

File: ANNAVG.E96

Pollutant Name	Emission Rate (g/s)
----------------	---------------------

---

1,3-BUTADIENE	3.020E-06
ACETALDEHYDE	2.800E-04
ACROLEIN	2.540E-05
AMMONIA	9.380E-02
BENZENE	2.290E-05
ETHYL BENZENE	2.240E-04
FORMALDEHYDE	2.520E-03
N-HEXANE	1.780E-03
NAPHTHALENE	1.140E-05
PAH:BENZO(A) PYRENE	1.230E-06
PROPYLENE (PROPENE)	5.300E-03
PROPYLENE OXIDE	2.030E-04
TOLUENE	9.140E-04
XYLENES	4.490E-04

---

EXPOSURE ROUTE INFORMATION

File: EXPOSURE.I96

---

Deposition Velocity (m/s) .....: 0.020

Fraction of Homegrown Produce ..: 0.000

Dilution Factor for Farm/Ranch X/Q (ug/m3)/(g/s) .....: 0.0000

Fraction of Animals' Diet From Grazing .....: 0.0000

Fraction of Animals' Diet From Impacted Feed .....: 0.0000

Fraction of Animals' Water Impacted by Deposition ....: 0.0000

    Surface Area (m2) .....: 0.000E+00

    Volume (liters) .....: 0.000E+00

    Volume Changes .....: 0.000E+00

Fraction of Meat in Diet Impacted ...: 0.0000

    Beef .....: 0.0000

    Pork .....: 0.0000

    Lamb/Goat .....: 0.0000

    Chicken .....: 0.0000

Fraction of Milk in Diet Impacted ...: 0.0000

    Goat Milk Fraction ...: 0.0000

Fraction of Eggs in Diet Impacted ...: 0.0000

Fraction of Impacted Drinking Water : 0.0000

    X/Q at water source ...: 0.0000

    Surface Area (m2) .....: 0.000E+00

    Volume (liters) .....: 0.000E+00

    Volume changes .....: 0.000E+00

Fraction of Fish from Impacted Water: 0.0000

    X/Q at Fish Source ....: 0.0000

    Surface Area (m2) .....: 0.000E+00

    Volume (liters) .....: 0.000E+00

    Volume changes .....: 0.000E+00

---

CHRONIC NONINHALATION EXPOSURE

Pollutant	Avg. Dose (mg/kg-d)	REL (mg/kg-d)	Avg Dose/REL
1,3-BUTADIENE	---	---	---
ACETALDEHYDE	---	---	---
ACROLEIN	---	---	---
AMMONIA	---	---	---
BENZENE	---	---	---
ETHYL BENZENE	---	---	---
FORMALDEHYDE	---	---	---
N-HEXANE	---	---	---
NAPHTHALENE	4.88E-09	---	---
PAH:BENZO (A) PYRENE	2.76E-10	---	---
PROPYLENE (PROPENE)	---	---	---
PROPYLENE OXIDE	---	---	---
TOLUENE	---	---	---
XYLENES	---	---	---

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INDIVIDUAL CANCER RISK REPORT

Run Made By  
nlm

Sierra Research

Project : SFPUC ERP

Feb. 18, 2004

Pollutant Database Date : Nov. 15, 2000  
Database Reference..... : CAPCOA Risk Assessment Guidelines

---

DILUTION FACTOR FOR POINT UNDER EVALUATION

X/Q (ug/m3)/(g/s) : 1.00E+00

---

ANNUAL AVERAGE EMISSION RATE INFORMATION

File: ANNAVG.E96

Pollutant Name	Emission Rate (g/s)
1,3-BUTADIENE	3.020E-06
ACETALDEHYDE	2.800E-04
ACROLEIN	2.540E-05
AMMONIA	9.380E-02
BENZENE	2.290E-05
ETHYL BENZENE	2.240E-04
FORMALDEHYDE	2.520E-03
N-HEXANE	1.780E-03
NAPHTHALENE	1.140E-05
PAH:BENZO (A) PYRENE	1.230E-06
PROPYLENE (PROPENE)	5.300E-03
PROPYLENE OXIDE	2.030E-04
TOLUENE	9.140E-04
XYLENES	4.490E-04

---

EXPOSURE ROUTE INFORMATION

File: EXPOSURE.I96

---

Deposition Velocity (m/s) .....: 0.020

Fraction of Homegrown Produce ..: 0.000

Dilution Factor for Farm/Ranch X/Q (ug/m3)/(g/s) .....: 0.0000

Fraction of Animals' Diet From Grazing .....: 0.0000

Fraction of Animals' Diet From Impacted Feed .....: 0.0000

Fraction of Animals' Water Impacted by Deposition ....: 0.0000

    Surface Area (m2) .....: 0.000E+00

    Volume (liters) .....: 0.000E+00

    Volume Changes .....: 0.000E+00

Fraction of Meat in Diet Impacted ...: 0.0000

    Beef .....: 0.0000

    Pork .....: 0.0000

    Lamb/Goat .....: 0.0000

    Chicken .....: 0.0000

Fraction of Milk in Diet Impacted ...: 0.0000

    Goat Milk Fraction ...: 0.0000

Fraction of Eggs in Diet Impacted ...: 0.0000

Fraction of Impacted Drinking Water : 0.0000

    X/Q at water source ...: 0.0000

    Surface Area (m2) .....: 0.000E+00

    Volume (liters) .....: 0.000E+00

    Volume changes .....: 0.000E+00

Fraction of Fish from Impacted Water: 0.0000

    X/Q at Fish Source ....: 0.0000

    Surface Area (m2) .....: 0.000E+00

    Volume (liters) .....: 0.000E+00

    Volume changes .....: 0.000E+00

---

44 YEAR  
INDIVIDUAL CANCER RISK BY POLLUTANT AND ROUTE

Pollutant	Air	Soil	Skin	Garden	MMilk	Other
1,3-BUTADIENE	3.23E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ACETALDEHYDE	4.75E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BENZENE	4.17E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FORMALDEHYDE	9.50E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PAH:BENZO (A) PYR	8.50E-10	1.31E-09	8.31E-10	0.00E+00	3.35E-09	0.00E+00
PROPYLENE OXIDE	4.72E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Route Total	1.20E-08	1.31E-09	8.31E-10	0.00E+00	3.35E-09	0.00E+00
TOTAL RISK: 1.75E-08						

70 YEAR  
INDIVIDUAL CANCER RISK BY POLLUTANT AND ROUTE

Pollutant	Air	Soil	Skin	Garden	MMilk	Other
1,3-BUTADIENE	5.13E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ACETALDEHYDE	7.56E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BENZENE	6.64E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FORMALDEHYDE	1.51E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PAH:BENZO (A) PYR	1.35E-09	2.03E-09	1.29E-09	0.00E+00	0.00E+00	0.00E+00
PROPYLENE OXIDE	7.51E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Route Total	1.92E-08	2.03E-09	1.29E-09	0.00E+00	0.00E+00	0.00E+00
TOTAL RISK: 2.25E-08						

APPENDIX 8.1D

## Construction Emissions and Impact Analysis

---

## **APPENDIX 8.1D**

### **CONSTRUCTION EMISSIONS AND IMPACT ANALYSIS**

#### **8.1D-1 Onsite Construction**

Construction of the project is expected to last approximately 17 months, including 5 months for demolition and site preparation and 12 months for construction.

Construction activities will occur in the following four main phases:

- Site preparation and water pipeline construction;
- Foundation work;
- Installation of major equipment; and
- Construction/installation of major structures.

Site preparation includes clearing, grading, excavation of footings and foundations, and backfilling operations. Construction of the water pipeline will occur during the site preparation/demolition phase of onsite construction. After site preparation is finished, the construction of the foundations and structures is expected to begin. Once the foundations and structures are finished, installation and assembly of the mechanical and electrical equipment are scheduled to commence.

Fugitive dust emissions from the construction of the project will result from:

- Dust entrained during site preparation and grading/excavation at the construction site;
- Dust entrained during trenching and repaving activities along the water pipeline route;
- Dust entrained during onsite travel on paved and unpaved surfaces;
- Dust entrained during aggregate and soil loading and unloading operations; and
- Wind erosion of areas disturbed during construction activities.

Combustion emissions during construction will result from:

- Exhaust from the Diesel construction equipment used for site preparation, grading, excavation, and construction of onsite structures;
- Exhaust from the Diesel excavator, paver, and trucks associated with water pipeline construction;
- Exhaust from water trucks used to control construction dust emissions;
- Exhaust from Diesel-powered welding machines, electric generators, air compressors, and water pumps;
- Exhaust from pickup trucks and Diesel trucks used to transport workers and materials around the construction site;
- Exhaust from Diesel trucks used to deliver concrete, fuel, and construction supplies to the construction site; and

- Exhaust from automobiles used by workers to commute to the construction site.

To determine the potential worst-case daily construction impacts, exhaust and dust emission rates have been evaluated for each source of emissions. Because of the staggered construction schedule, site preparation and equipment installation may be occurring simultaneously. Therefore, maximum short-term impacts are calculated assuming that all equipment is operating simultaneously with the peak workforce (250 persons) on-site. Annual emissions are based on the average equipment mix during the 17-month construction/demolition period.

### **8.1D-2 Linear Facilities**

Offsite construction will include a natural gas pipeline and process water line. Emissions from these construction activities are included in this analysis.

### **8.1D-3 Available Mitigation Measures**

The following mitigation measures are proposed to control exhaust emissions from the Diesel heavy equipment used during construction of the project:

- Operational measures, such as limiting time spent with the engine idling by shutting down equipment when not in use;
- Regular preventive maintenance to prevent emission increases due to engine problems;
- Use of low sulfur and low aromatic fuel meeting California standards for motor vehicle Diesel fuel; and
- Use of low-emitting Diesel engines meeting federal emissions standards for construction equipment.

The following mitigation measures are proposed to control fugitive dust emissions during construction of the project:

- Use either water application or chemical dust suppressant application to control dust emissions from unpaved road travel and unpaved parking areas;
- Use vacuum sweeping and/or water flushing of paved road surface to remove buildup of loose material to control dust emissions from travel on the paved access road (including adjacent public streets impacted by construction activities) and paved parking areas;
- Cover all trucks hauling soil, sand, and other loose materials or require all trucks to maintain at least 2 feet of freeboard;
- Limit traffic speeds on unpaved roads to 15 mph;
- Install sandbags or other erosion control measures to prevent silt runoff to roadways;
- Replant vegetation in disturbed areas as quickly as possible;
- Use wheel washers or wash off tires of all trucks exiting construction site that carry track-out dirt from unpaved roads; and

- Mitigate fugitive dust emissions from wind erosion of areas disturbed from construction activities (including storage piles) by application of either water or chemical dust suppressant.

## 8.1D-4 Estimation of Emissions with Mitigation Measures

### 8.1D-4.1 Onsite Construction

Tables 8.1D-1 and 8.1D-2 show the estimated maximum daily and annual heavy equipment exhaust and fugitive dust emissions with recommended mitigation measures for onsite construction activities. Detailed emission calculations are included as Attachment 8.1D-1.

**Table 8.1D-1**

Maximum Daily Emissions During Onsite Construction, Pounds Per Day

	NOx	CO	POC	SOx	PM <sub>10</sub>	PM <sub>2.5</sub>
Onsite						
Construction Equipment	53.0	33.2	6.4	0.06	3.7	3.7
Fugitive Dust	--	--	--	--	16.7	5.1
Offsite						
Worker Travel, Truck Deliveries	86.5	253.9	26.4	0.9	2.4	2.4
Total Emissions						
Total	139.5	287.1	32.8	0.9	22.9	11.2

**Table 8.1D-2**

Annual Emissions During Construction, Tons Per Year

	NOx	CO	POC	SOx	PM <sub>10</sub>	PM <sub>2.5</sub>
Onsite						
Construction Equipment	5.6	3.4	0.6	0.01	0.4	0.4
Fugitive Dust	--	--	--	--	1.5	0.5
Offsite						
Worker Travel, Truck Deliveries	4.6	18.0	1.8	0.04	0.1	0.1
Total Emissions						
Total	10.2	21.4	2.5	0.05	2.0	1.0

### 8.1D-4.2 Linear Facilities Construction

The estimated maximum daily heavy equipment exhaust and fugitive dust emissions with recommended mitigation measures for the natural gas pipeline construction activities are included in the onsite construction analysis. Table 8.1D-3 shows the estimated maximum daily equipment exhaust and fugitive dust emissions with mitigation during water pipeline construction. Detailed emissions calculations are shown in Attachment 8.1D-1.

**Table 8.1D-3**

Maximum Daily Emissions During Water Pipeline Construction, Pounds Per Day

	NOx	CO	POC	SOx	PM <sub>10</sub>	PM <sub>2.5</sub>
Construction Equipment	17.3	7.6	1.3	0.06	0.7	0.7
Fugitive Dust	--	--	--	--	0.4	0.08
Worker Travel, Truck Deliveries	18.7	23.0	2.6	0.2	0.4	0.4
Total Emissions						
Total	36.0	30.1	3.9	0.3	1.6	1.2

### 8.1D-5 Analysis of Ambient Impacts from Onsite Construction

Ambient air quality impacts from emissions during construction of the project were estimated using an air quality dispersion modeling analysis. The modeling analysis considers the construction site location, the surrounding topography, and the sources of emissions during construction, including vehicle and equipment exhaust emissions and fugitive dust.

#### 8.1D-5.1 Existing Ambient Levels

As with the modeling analysis of project operating impacts (Section 8.1.2), the Arkansas Street (San Francisco) monitoring station was used to establish the ambient background levels for the construction impact modeling analysis. Table 8.1-4.3 shows the maximum concentrations of NOx, SO<sub>2</sub>, CO, and PM<sub>10</sub> recorded for 2000 through 2002 at that monitoring station.

#### 8.1D-5.2 Dispersion Model

As in the analysis of project operating impacts, the EPA-approved Industrial Source Complex Short Term (ISCST3) model was used to estimate ambient impacts from construction activities. A detailed discussion of the ISCST3 dispersion model is included in Section 8.1.5.3.1.

The emission sources for the construction site were grouped into three categories: exhaust emissions, construction dust emissions and windblown dust emissions. The exhaust and construction dust emissions were modeled as volume sources. The windblown dust emissions were modeled as area sources. For the volume sources, the vertical dimension was set to 6 meters. For combustion sources in the construction area, the horizontal dimension was set to 154.58 meters, with sigma-y = 35.95 meters (based on the width of the construction area). For combustion sources in the construction laydown area, the horizontal dimension was set to 209.78 meters, with sigma-y = 48.79 meters (corresponding to the width of the laydown area).

For the windblown dust sources, the area covers the entire site plan. An effective plume height of 0.5 meters was used in the modeling analysis. The exhaust and dust emissions were modeled as a single area source that covered the total area of the construction site. The construction impacts modeling analysis used the same receptor locations as used for

the project operating impact analysis. A detailed discussion of the receptor locations is included in Section 8.1.5.3.1.

To determine the construction impacts on short-term ambient standards (24 hours and less), the worst-case daily onsite construction emission levels shown in Table 8.1D-1 were used. For pollutants with annual average ambient standards, the annual onsite emission levels shown in Table 8.1D-2 were used. As with the project operating impact analysis, the meteorological data set used for the construction emission impacts analysis is the ambient data collected at the nearby Arkansas Street monitoring station between 2000 and 2002.

#### **8.1D-4.5.3 Modeling Results**

Based on the emission rates of NO<sub>x</sub>, SO<sub>2</sub>, CO, and PM<sub>10</sub> and the meteorological data, the ISCST3 model calculates hourly and annual ambient impacts for each pollutant. As mentioned above, the modeled 1-hour, 3-hour, 8-hour, and 24-hour ambient impacts are based on the worst-case daily emission rates of NO<sub>x</sub>, SO<sub>2</sub>, CO, and PM<sub>10</sub>. The annual impacts are based on the annual emission rates of these pollutants.

The one-hour and annual average concentrations of NO<sub>2</sub> were computed following the revised EPA guidance for computing these concentrations (August 9, 1995 *Federal Register*, 60 FR 40465). The ISC\_OLM model was used for the one-hour average NO<sub>2</sub> impacts; uncorrected one-hour impacts are also reported for comparison. The annual average was calculated using the ambient ratio method (ARM) with the national default value of 0.75 for the annual average NO<sub>2</sub>/NO<sub>x</sub> ratio.

The modeling analysis results are shown in Table 8.1D-4. Also included in the table are the maximum background levels that have occurred in the last 3 years and the resulting total ambient impacts. Construction impacts alone for all modeled pollutants are expected to be below the most stringent state and national standards. With the exception of the 24-hour and annual average PM<sub>10</sub>, construction activities are not expected to cause the violation of any state or federal ambient air quality standard. However, the state 24-hour and annual average PM<sub>10</sub> standards are exceeded in the absence of the construction emissions for the project.

The dust mitigation measures already proposed by the applicant are expected to be very effective in minimizing fugitive dust emissions. The attached isopleth diagrams show the extent of the modeled impacts from construction PM<sub>10</sub> and PM<sub>2.5</sub> for the 24-hour and annual averaging periods.

**Table 8.1D-4**

Modeled Maximum Onsite Construction Impacts

Pollutant	Averaging Time	Maximum Construction Impacts ( $\mu\text{g}/\text{m}^3$ )	Background ( $\mu\text{g}/\text{m}^3$ )	Total Impact ( $\mu\text{g}/\text{m}^3$ )	Standard ( $\mu\text{g}/\text{m}^3$ )	Federal Standard ( $\mu\text{g}/\text{m}^3$ )
NO <sub>2</sub> <sup>a</sup>	1-hour	89.6	141	231	470	--
	Annual	2.1	38	40	--	100
SO <sub>2</sub>	1-hour	0.3	138	138	650	--
	24-hour	0.04	21	21	109	365
	Annual	0.03	5.3	5.3	--	80
CO	1-hour	154.2	6,875	7,029	23,000	40,000
	8-hour	63.2	3,644	3,707	10,000	10,000
PM <sub>10</sub>	24-hour	14.9	74	89	50	150
	Annual	1.3	24.7	26	20	50
PM <sub>2.5</sub>	24-hour	6.4	77	83	--	65
	Annual	0.6	13.1	14	12	15

Notes:

- a. Ozone limiting method applied for 1-hour average, using concurrent O<sub>3</sub> data (1992). ARM applied for annual average, using national default 0.75 ratio. Uncorrected 1-hour NO<sub>x</sub> concentration is 246  $\mu\text{g}/\text{m}^3$ .

As shown on these isopleths, while maximum impacts occur next to the project site fenceline, concentrations decrease rapidly at locations only a couple of hundred meters away from the project site. For example, as shown on the isopleths for 24-hour average PM<sub>10</sub> impacts, along the fenceline PM<sub>10</sub> impacts are approximately 15  $\mu\text{g}/\text{m}^3$ . However, at locations only 500 meters away from the fenceline PM<sub>10</sub> impacts decrease to less than 2  $\mu\text{g}/\text{m}^3$  (approximately 10% of the level at the fenceline).

It is also important to note that emissions in an exhaust plume are dispersed through the entrainment of ambient air, which dilutes the concentration of the emissions as they are carried away from the source by winds. The process of mixing the pollutants with greater and greater volumes of cleaner air is controlled primarily by the turbulence in the atmosphere. This dispersion occurs both horizontally, as the exhaust plume rises above the emission point, and vertically, as winds carry the plume horizontally away from its source.

The rise of a plume above its initial point of release is a significant contributing factor to the reductions in ground-level concentrations, both because a rising plume entrains more ambient air as it travels downwind, and because it travels farther downwind (and thus also undergoes more horizontal dispersion) before it impacts the ground. Vertical plume rise occurs as a result of buoyancy (plume is hotter than ambient air, and hot air, being less dense, tends to rise) and/or momentum (plume has an initial vertical velocity).

In ISCST3, area sources are not considered to have either buoyant or momentum plume rise, and therefore the model assumes that there is no vertical dispersion taking place. Thus a significant source of plume dilution is ignored when sources are modeled as area sources. The project construction site impacts are not unusual in comparison to most construction sites; construction sites that use good dust suppression techniques and low-emitting vehicles typically do not cause violations of air quality standards. The input and output modeling files are being provided electronically.

#### **8.1D-5.4 Health Risk of Diesel Exhaust**

The combustion portion of annual PM<sub>10</sub> emissions from Table 8.1D-4 above was modeled separately to determine the annual average Diesel PM<sub>10</sub> exhaust concentration.

This was used with the ARB-approved unit risk value of 350 in one million for a 70-year lifetime<sup>1</sup> to determine the potential carcinogenic risk from Diesel exhaust during construction. The exposure was also adjusted by a factor of 17/840, or 0.0202, to correct for the 17-month exposure.

The maximum modeled annual average concentration of Diesel exhaust PM<sub>10</sub> at any location is 0.175 µg/m<sup>3</sup>. Using the unit risk value and adjustment factors described above, the carcinogenic risk due to exposure to Diesel exhaust during construction activities is expected to be approximately 1.2 in one million. This is well below the 10 in one million level considered to be significant.

It is also important to note that these impacts are highly localized near the project site. At the nearest residence the annual average concentration of Diesel exhaust PM<sub>10</sub> is approximately 0.01 µg/m<sup>3</sup> resulting in a carcinogenic risk of approximately 0.06 in one million. As shown in the attached annual average Diesel combustion PM<sub>10</sub> isopleth diagram (Figure 8.1D-3), the area in which the risk may exceed 1 in one million (Diesel PM<sub>10</sub> impact greater than or equal to 0.141 µg/m<sup>3</sup>) extends about only about 100 meters from the facility fenceline. This analysis remains conservative because, as discussed above, the modeled PM<sub>10</sub> concentrations from construction operations are overpredicted by the ISCST3 model.

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<sup>1</sup> For a single-point assessment of cancer risk at residential receptors, an interim policy issued by CARB recommends that the cancer risk be calculated using the midpoint (80<sup>th</sup> percentile) breathing rate of the mean (65<sup>th</sup> percentile) and the high-end (95<sup>th</sup> percentile) from the OEHHA guidelines. Thus, a breathing rate of 332 L/kg-day (midpoint of 271 and 393 L/kg-day) is used in this assessment to calculate the maximum offsite cancer risk. The basis for the Unit Risk Value is a standard breathing rate of 30 m<sup>3</sup>/day, which is equivalent to 286 L/kg-day (at an average weight of 70 kg). Thus the Unit Risk Value for Diesel goes from 300 in one million to 350 in one million (300 x 332/286).

Figure 8.1D-1

Maximum One-Hour Average NO<sub>2</sub> Impacts During Construction Activities  
(Ozone-Limited)

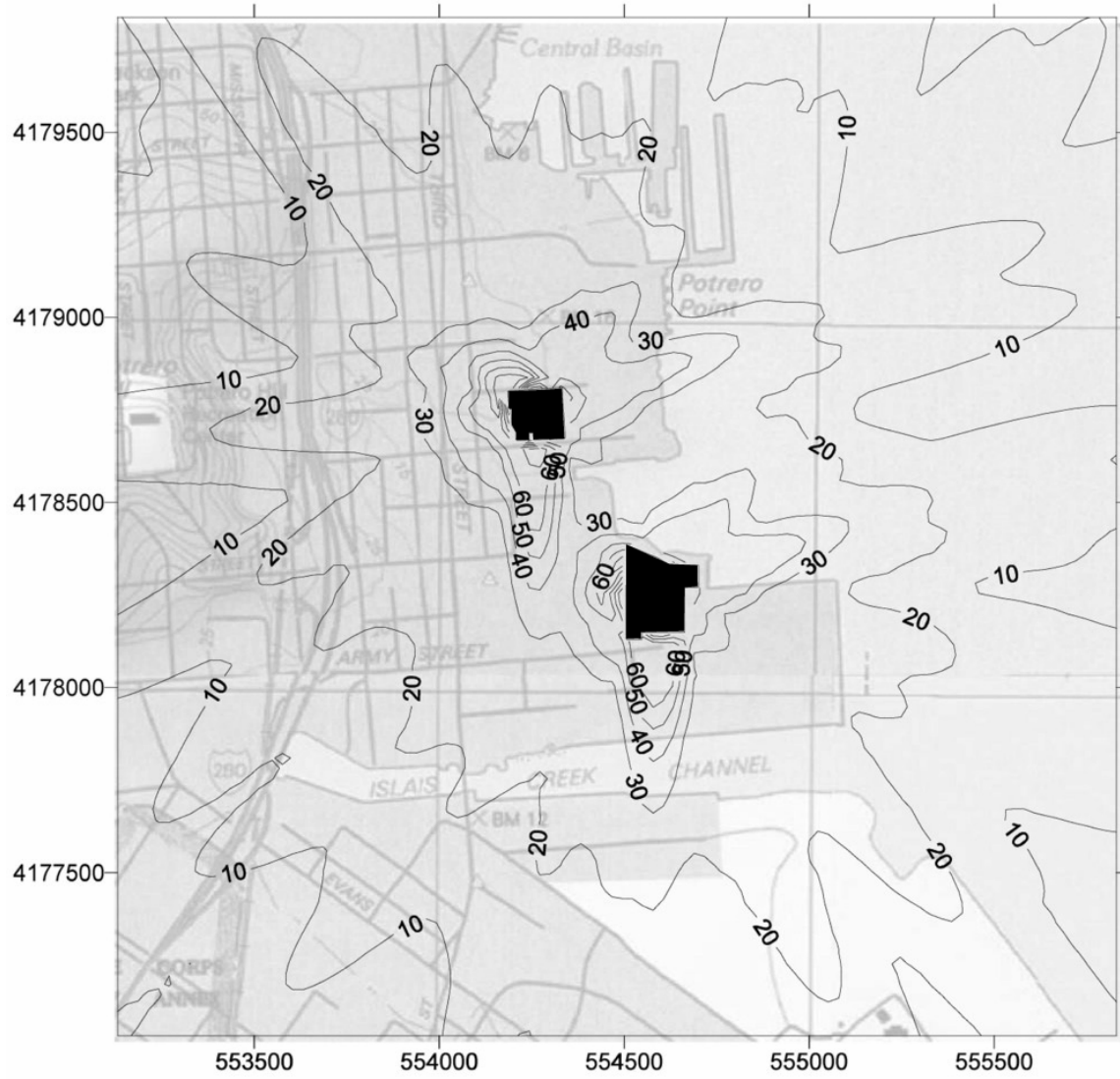


Figure 8.1D-2

Maximum 24-Hour Average PM<sub>10</sub> Impacts During Construction Activities, All Sources

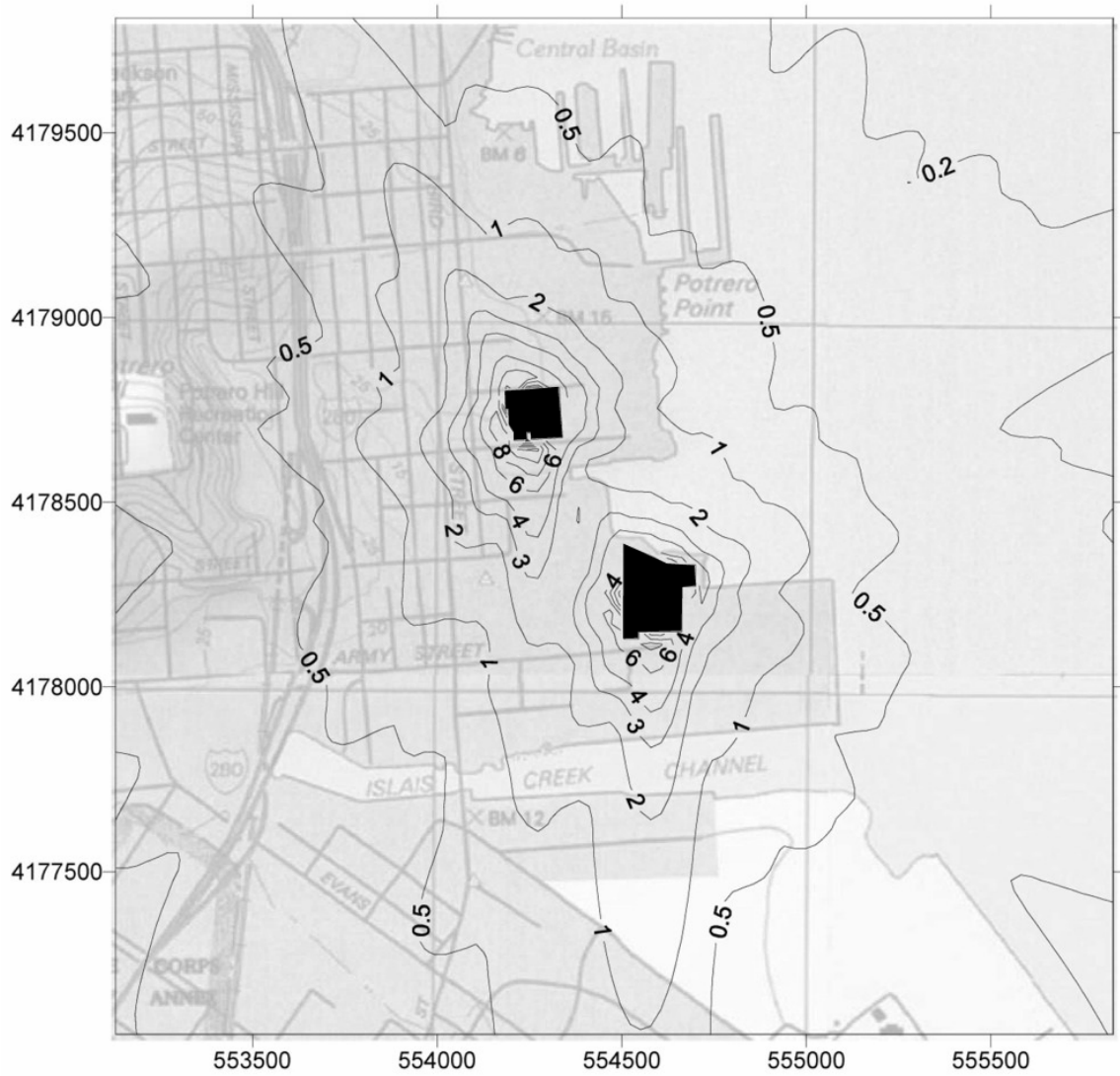


Figure 8.1D-3a

Maximum Annual Average PM<sub>10</sub> Impacts During Construction Activities, Combustion Sources

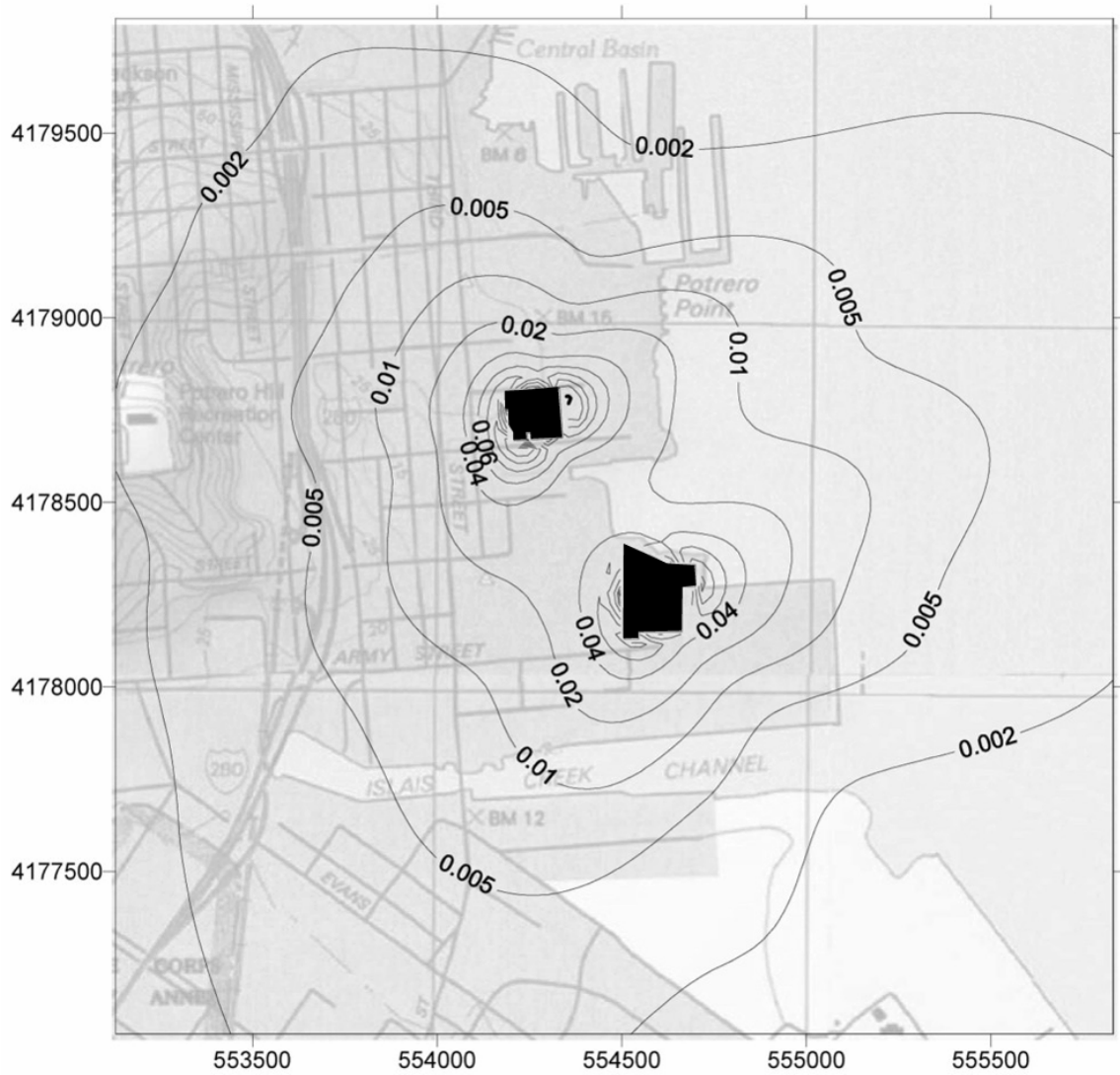


Figure 8.1D-3b

Maximum Annual Average PM<sub>10</sub> Impacts During Construction Activities,  
Combustion Sources (detail)

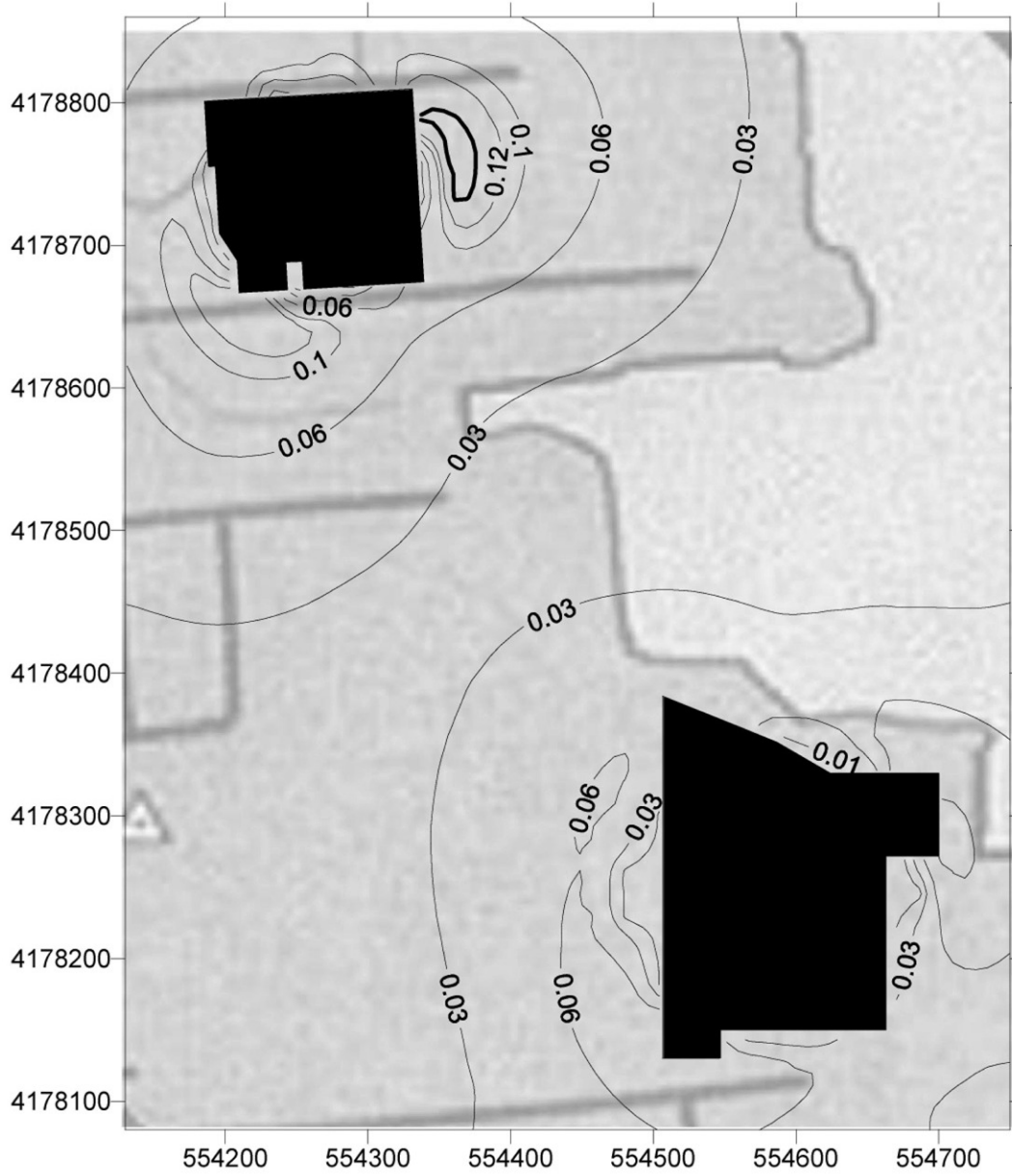
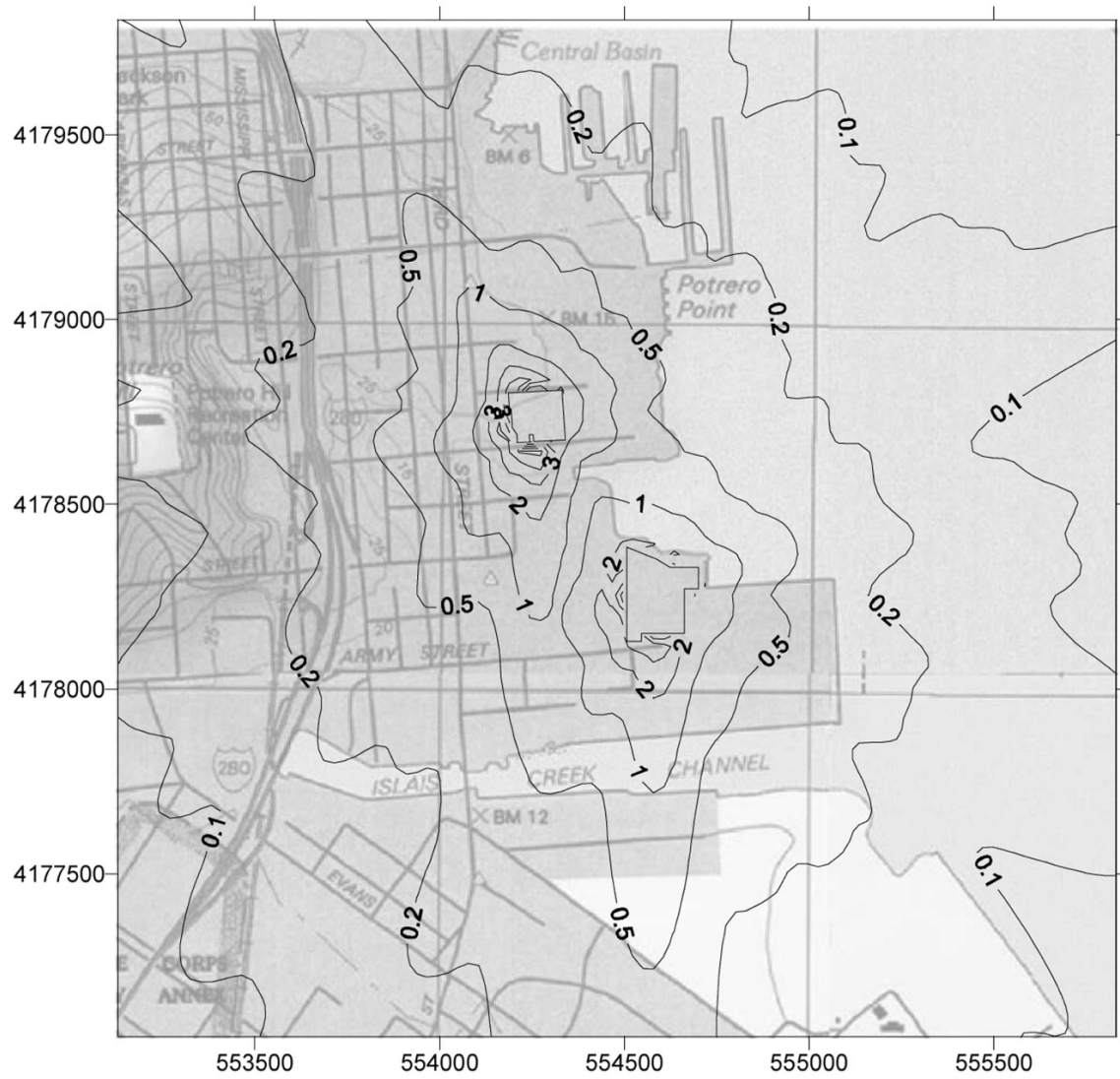


Figure 8.1D-4

Maximum 24-Hour Average PM<sub>10</sub> Impacts During Construction Activities,  
All Sources



## **Attachment 8.1D-1 Detailed Construction Emissions Calculations**

Daily Construction Emissions (peak months)						
(lbs/day)						
	NOx	CO	VOC	SOx	PM2.5	PM10
Onsite						
Construction Equipment	53.00	33.23	6.42	0.06	3.73	3.73
Fugitive Dust					5.06	16.73
Subtotal =	53.00	33.23	6.42	0.06	8.79	20.47
Offsite						
Worker Travel	21.99	216.95	21.56	0.12	1.03	1.03
Truck Deliveries	64.49	36.92	4.81	0.75	1.39	1.39
Subtotal =	86.48	253.87	26.37	0.87	2.42	2.42
Total =	139.48	287.10	32.79	0.93	11.21	22.89

Annual Construction Emissions (peak 12-month period)						
(tons/yr)						
	NOx	CO	VOC	SOx	PM2.5	PM10
Onsite						
Construction Equipment	5.55	3.40	0.63	0.01	0.35	0.35
Fugitive Dust					0.46	1.50
Subtotal =	5.55	3.40	0.63	0.01	0.81	1.85
Offsite						
Worker Travel	1.65	16.32	1.62	0.01	0.08	0.08
Truck Deliveries	2.98	1.70	0.22	0.03	0.06	0.06
Subtotal =	4.63	18.03	1.84	0.04	0.14	0.14
Total =	10.19	21.43	2.47	0.05	0.95	1.99

Dust Emission Ranking																			
Equipment	Hrs/Day Per Unit (1)	PM10 lbs/hr Per Unit	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Grader	7	0.06	0.00	0.00	0.00	0.00	0.00	0.45	0.45	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dozer	7	0.42	0.00	0.00	0.00	0.00	0.00	2.94	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scraper	7	0.83	0.00	0.00	0.00	0.00	0.00	5.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forklift	7	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.27	3.81	3.81	3.81	3.81	3.81	3.81	3.81	2.54	0.00
Backhoe	7	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.99	3.99	3.99	3.99	3.99	3.99	3.99	2.66	0.00	0.00
Crane	7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Loader	7	0.04	0.53	0.53	0.79	0.79	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field truck (3/4T)	7	0.13	0.00	0.00	0.00	0.00	0.00	0.88	0.88	0.88	0.88	0.88	1.76	1.76	1.76	1.76	0.88	0.88	0.88
Wrecking Ball	7	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dump truck	7	0.19	5.43	5.43	5.43	5.43	5.43	1.36	1.36	1.36	2.71	2.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water truck	7	0.30	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Service truck	7	0.09	0.00	0.00	0.00	5.70	0.00	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.00	0.00	0.00
Fuel Truck	7	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00
Boom truck	7	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Concrete pump	7	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Port air compressor	7	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Port. Light plant	7	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total =			1	1	1	1	1	10	4	7	9	9	10	10	10	10	7	3	1
			5%	5%	8%	8%	8%	100%	42%	66%	86%	86%	95%	95%	95%	95%	73%	34%	9%
12-month Total =													61	70	79	85	88	88	

Note: (1) 7 hours of equipment operation during 10 hrs/day of construction activity.

Daily Fugitive Dust Emissions (peak months)									
Equipment	Number of Units	Daily Process Rate Per Unit	Total Process Rate	Units	PM2.5 Emission Factor(1) (lbs/unit)	PM10 Emission Factor(1) (lbs/unit)	Control Factor(1) (%)	PM2.5 Emissions (lbs/day)	PM10 Emissions (lbs/day)
Backhoe	0	882.0	0.0	tons	5.305E-05	0.0015	0%	0.00	0.00
Grader	1	21.0	21.0	vmt	0.0193297	0.2754	92%	0.03	0.45
Dozer	1	7.0	7.0	hr	0.23	0.4194	0%	1.62	2.94
Scraper - Excavation	1	7.0	7.0	hr	0.23	0.4194	0%	1.62	2.94
Scraper - Unpaved Road Travel	1	10.6	10.6	vmt	0.53	3.4638	92%	0.44	2.86
Loader - Excavation	0	735.0	0.0	tons	2.827E-05	0.0001	0%	0.00	0.00
Loader - Unpaved Road Travel	0	1.3	0.0	vmt	0.29	1.9201	92%	0.00	0.00
Water Truck Unpaved Road Travel	1	9.5	9.5	vmt	0.44	2.8400	92%	0.32	2.11
Forklift Unpaved Road Travel	0	9.5	0.0	vmt	0.26	1.7100	92%	0.00	0.00
Dump Truck Unpaved Road Travel	1	5.6	5.6	vmt	0.46	2.9806	92%	0.20	1.29
Dump Truck Unloading	1	735.0	735.0	tons	2.827E-05	0.0001	0%	0.02	0.07
3/4 ton Truck Unpaved Road Travel	1	11.4	11.4	vmt	0.15	0.9947	92%	0.13	0.88
3 ton Truck Unpaved Road Travel	1	5.7	5.7	vmt	0.22	1.4328	92%	0.10	0.63
Fuel Truck Unpaved Road Travel	1	0.1	0.1	vmt	0.33	2.1349	92%	0.00	0.02
Windblown Dust (active construction area)	N/A	573,830.8	573,830.8	sq.ft.	6.728E-06	1.682E-05	92%	0.30	0.75
Worker Gravel Road Travel	192	0.1	21.9	vmt	0.12	0.7705	92%	0.20	1.31
Delivery Truck Gravel Road Travel	13	0.1	1.5	vmt	0.35	2.3088	92%	0.04	0.27
Delivery Truck Unpaved Road Travel	13	0.1	1.0	vmt	0.46	2.9806	92%	0.04	0.23
Total =								5.06	16.73

Notes:

(1) See notes for fugitive dust emission calculations.

Annual Fugitive Dust Emissions					
Activity	Average Daily PM2.5 Emissions(1) (lbs/day)	Average Daily PM10 Emissions(1) (lbs/day)	Days per Year	Annual PM2.5 Emissions (tons/yr)	Annual PM10 Emissions (tons/yr)
Construction Activities	3.47	11.67	240	0.42	1.40
Windblown Dust	0.22	0.55	365	0.04	0.10
Total =				0.46	1.50

Notes:

(1) Based on average of daily emissions during peak 12-month construction period.

## Notes - Fugitive Dust Emission Calculations

Wind erosion of active construction area - 'Source: "Improvement of Specific Emission Factors (BACM Project No. 1), Final Report", prepared for South Coast AQMD by Midwest Research Institute, March 1996

Level 2 Emission Factor =	0.011 ton/acre-month
Construction Schedule =	30 days/month
=	0.7 lbs/acre-day
=	1.682E-05 PM10 lbs/scf-day
	6.728E-06 PM2.5 lbs/scf-day

Material Unloading - Source: AP-42, p. 13.2.4-3, 1/95

$E = (k)(0.0032)[(U/5)^{1.3}]/[(M/2)^{1.4}]$	
k = particle size constant =	0.35 for PM10
k = particle size constant =	0.11 for PM2.5
U = average wind speed =	2.81 m/sec (based on project area wind data)
=	6.29 mph
M = moisture content =	15.0% (SCAQMD CEQA Handbook, Table A9-9-G-1, moist soil)
E = PM10 emission factor =	0.0001 lb/ton
E = PM2.5 emission factor =	0.00003 lb/ton

Loader Unpaved Road Travel - Source: AP-42, Section 13.2.2, 12/03

$E = (k)[(s/12)^{0.9}]/[(W/3)^{0.45}]$	
k = particle size constant =	1.5 for PM10
k = particle size constant =	0.23 for PM2.5
s = surface silt content =	8.50 (AP-42, Table 13.2.2-1, 12/03, construction haul route)
W = avg. vehicle weight =	10.35 tons (avg. of loaded and unloaded weights, 966F loader, Caterpillar Performance Handbook, 10/97)
E = PM10 emission factor =	1.92 lb PM10/VMT
E = PM2.5 emission factor =	0.29 lb PM2.5/VMT
Soil Density =	1.05 ton/yd <sup>3</sup> (Caterpillar Performance Handbook, 10/89)
Loader Bucket Capacity =	5 yd <sup>3</sup> (966F loader, Caterpillar Performance Handbook, 10/97)
=	5.25 ton/load
Daily Soil Transfer Rate =	735 ton/day (operating 7 hrs/day)
Daily Loader Trips =	140 loading trips/day
Loading Travel Distance =	50 ft/load (estimated)
Daily Loader Travel Distance =	7,000 ft/day
=	1.3 mi/day

Notes - Fugitive Dust Emission Calculations

Backhoe Trenching - Source: AP-42, Table 11.9-1 (dragline operations), 7/98

$$E = (0.75)(0.0021)(d^{0.7})/(M^{0.3})$$

d = drop height = 3 ft (estimated)  
M = moisture content = 15.0% (SCAQMD CEQA Handbook, Table A9-9-G-1, moist soil)  
E = PM10 emission factor = 0.0015 PM10 lb/ton  
E = PM2.5 emission factor = 0.0001 PM2.5 lb/ton  
Backhoe Excavating Rate = 120.0 yd3/hr (based on 1 yd3 bucket on a 416C backhoe and a 30 sec. Cycle time)  
= 840 yd3/day for 1 backhoe @ 7 hrs/day of operation  
Soil Density = 1.0500 ton/yd3 (Caterpillar Performance Handbook, 10/89)  
Daily Soil Transfer Rate = 882.0000 ton/day (estimated)

Unpaved Road Travel - Source: AP-42, Section 13.2.2, 12/03.

$$E = (k)[(s/12)^{0.9}(W/3)^{0.45}]$$

k = particle size constant = 1.5 for PM10  
k = particle size constant = 0.23 for PM2.5  
s = silt fraction = 8.50 (AP-42, Table 13.2.2-1, 12/03, construction)

W = water truck avg. veh. weight = 10.0 tons empty (estimated)  
= 39.4 tons loaded (estimated with 8,000 gallon water capacity)  
= 24.7 tons average

W = dump truck avg. veh. weight = 15.0 tons (for heavy duty Diesel trucks)  
= 40.0 tons (for heavy duty Diesel trucks)  
= 27.5 tons (for heavy duty Diesel trucks)  
W = forklift avg. veh. weight = 8.0 tons empty (estimated)  
W = auto/pickup avg. vehicle weight = 2.4 tons (CARB Area Source Manual, 9/97)  
W = delivery truck avg. veh. wt. = 27.5 tons (for heavy duty Diesel trucks)  
W = 3 ton truck avg. veh. Wt = 5.4 tons (estimate)  
W = scraper avg. veh. wt. = 28.2 tons empty (615 scraper, Caterpillar Performance Handbook, 10/89)  
48.6 tons loaded (615 scraper, Caterpillar Performance Handbook, 10/89)  
38.4 tons mean weight  
8.0 tons empty (estimated)  
18.2 tons loaded (estimated with 3,000 gallons Diesel fuel capacity)  
= 13.1 tons average

Gravel Road Travel - Source: AP-42, Section 13.2.2, 12/03.

$$E = (k)[(s/12)^{0.9}(W/3)^{0.45}]$$

k = particle size constant = 1.5 for PM10  
k = particle size constant = 0.23 for PM2.5  
s = silt fraction = 6.40 (AP-42, Table 13.2.2-1, 12/03, gravel road)

W = water truck avg. veh. weight = 10.0 tons empty (estimated)  
= 39.4 tons loaded (estimated with 8,000 gallon water capacity)  
= 24.7 tons average

W = dump truck avg. veh. weight = 15.0 tons (for heavy duty Diesel trucks)  
= 40.0 tons (for heavy duty Diesel trucks)  
= 27.5 tons (for heavy duty Diesel trucks)  
W = forklift avg. veh. weight = 8.0 tons empty (estimated)  
W = auto/pickup avg. vehicle weight = 2.4 tons (CARB Area Source Manual, 9/97)  
W = delivery truck avg. veh. wt. = 27.5 tons (for heavy duty Diesel trucks)

## Notes - Fugitive Dust Emission Calculations

E = water truck emission factor = 2.84 lb PM10/VMT  
 E = dump truck emission factor = 2.98 lb PM10/VMT  
 E = forklift emiss. factor = 1.71 lb PM10/VMT  
 E = auto/pickup emiss. factor = 0.99 lb PM10/VMT  
 E = delivery truck emiss. factor = 2.98 lb PM10/VMT  
 E = 3-ton truck emiss. factor = 1.43 lb PM10/VMT  
 E = scaper emiss. factor = 3.46 lb PM10/VMT  
 E = fuel truck emiss. factor = 2.13 lb PM10/VMT

E = water truck emission factor = 0.44 lb PM2.5/VMT  
 E = dump truck emission factor = 0.46 lb PM2.5/VMT  
 E = forklift emiss. factor = 0.26 lb PM2.5/VMT  
 E = auto/pickup emiss. factor = 0.15 lb PM2.5/VMT  
 E = delivery truck emiss. factor = 0.46 lb PM2.5/VMT  
 E = 3-ton truck emiss. factor = 0.22 lb PM2.5/VMT  
 E = scaper emiss. factor = 0.53 lb PM2.5/VMT  
 E = fuel truck emiss. factor = 0.33 lb PM2.5/VMT

E = auto/pickup emiss. factor = 0.77 lb PM10/VMT  
 E = delivery truck emiss. factor = 2.31 lb PM10/VMT

E = auto/pickup emiss. factor = 0.12 lb PM2.5/VMT  
 E = delivery truck emiss. factor = 0.35 lb PM2.5/VMT

## Unpaved Road Travel and Active Excavation Area Control - Source: Control of Open Fugitive Dust Sources, U.S EPA, 9/88

$$C = 100 - (0.8)(p)(d)(t)/(i)$$

p = potential average hourly daytime

evaporation rate =

0.3575 mm/hr (EPA document, Figure 3-2, summer)

evaporation rate =

0.2695 mm/hr (EPA document, Figure 3-2, annual)

d = average hourly daytime traffic rate =

37.0 vehicles/hr (estimated)

t = time between watering applications =

1.00 hr/application (estimated)

i = application intensity =

1.4 L/m<sup>2</sup> (typical level in EPA document, page 3-23)

C = average summer watering control efficiency

92.2%

C = average annual watering control efficiency

94.1%

## Finish Grading - Source: AP-42, Table 11.9-1, 7/98

$$E = (0.60)(0.051)(S^{2.0})$$

S = mean vehicle speed =

3.0 mph (estimate)

E = emission factor =

0.2754 PM10 lb/VMT

E = emission factor =

0.0193 PM2.5 lb/VMT

## Notes - Fugitive Dust Emission Calculations

Bulldozer Operation and Scraper Excavation - Source: AP-42, Table 11.9.1, 7/98

$$E = (0.75)(s^{1.5})/(M^{1.4})$$

s = silt content =	8.5% (AP-42, Table 13.2.2-1, 9/98, construction haul route)
M = moisture content =	15.0% (SCAQMD CEQA Handbook, Table A9-9-G-1)
E = emission factor =	0.42 PM10 lb/hr
E = emission factor =	0.23 PM2.5 lb/hr

## Scraper Travel

W = mean vehicle weight =	28.2 tons empty (615E scraper, Caterpillar Performance Handbook, 10/89)
=	48.6 tons loaded (615E scraper, Caterpillar Performance Handbook, 10/89)
=	38.4 tons mean weight

Daily Scraper Haul Tonnage = 1,428 ton/day (estimated)

Scraper Load = 20.4 ton (615E scraper, Caterpillar Performance Handbook, 10/89)

Daily Scraper Loads = 70.00 loads/day

Daily Scraper Hauling Distance = 0.08 miles/load (estimated)

Daily Scraper Travel = 10.61 miles/day

#### Notes - Fugitive Dust Emission Calculations

- (1) Wind erosion emission factor for active construction area is based on "Improvement of Specific Emission Factors (BACM Project No. 1), Final Report", prepared for South Coast AQMD by Midwest Research Institute, March 1996.
- (2) Material unloading emission factors are based on AP-42, p. 13.2.4-3, 1/95.  
(Based on average annual wind speed recorded onsite and default soil moisture contents.)
- (3) Trenching emission factor is based on AP-42, Table 11.9-2 (dragline operations), 1/95.  
(Based on default soil moisture content.)
- (4) Unpaved surface travel emission factors for water trucks, loaders, dump trucks, forklifts, delivery trucks, are based on AP-42, Section 13.2.2, 12/2003.  
(Based on default soil silt content.)
- (5) Dust control efficiency for unpaved road travel and active excavation area is based on "Control of Open Fugitive Dust Sources", U.S. EPA, 9/88.  
(Based on default evaporation rate shown in EPA document, Figure 3-2, 9/88, and typical water application rate shown in EPA document, page 3-23, 9/88.)

Combustion Emission Ranking																			
Equipment	Hrs/Day Gals/Hr		Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month
	Per Unit (1)	Per Unit																	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Grader	7	5.00	0	0	0	0	0	35	35	35	0	0	0	0	0	0	0	0	0
Dozer	7	5.50	0	0	0	0	0	39	39	0	0	0	0	0	0	0	0	0	0
Scraper	7	9.00	0	0	0	0	0	63	0	0	0	0	0	0	0	0	0	0	0
Forklift	7	2.50	0	0	0	0	0	0	0	18	53	53	53	53	53	53	53	35	0
Backhoe	7	2.50	0	0	0	0	0	0	0	53	53	53	53	53	53	53	35	0	0
Crane	7	5.00	0	0	0	0	0	0	0	35	35	70	70	70	70	35	0	0	0
Loader	7	2.50	35	35	53	53	53	0	0	0	0	0	0	0	0	0	0	0	0
Field truck (3/4T)	7	0.78	0	0	0	0	0	5	5	5	5	5	11	11	11	11	5	5	5
Wrecking Ball	7	5.00	35	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dump truck	7	3.13	88	88	88	88	88	22	22	22	44	44	0	0	0	0	0	0	0
Water truck	7	3.13	22	22	22	22	22	22	22	22	22	22	0	0	0	0	0	0	0
Service truck	7	1.56	0	0	0	98	0	11	11	11	11	11	11	11	11	11	0	0	0
Fuel Truck	7	3.13	0	0	0	0	0	22	22	22	22	22	22	22	22	22	22	0	0
Boom truck	7	1.56	0	0	0	0	0	0	0	0	11	11	11	11	11	11	11	0	0
Concrete pump	7	3.13	0	0	0	0	0	0	22	44	44	44	22	22	0	0	0	0	0
Port air compressor	7	1.27	0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	0	0
Port. Light plant	7	1.27	0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	0	0
Total =			35	35	53	53	53	142	79	145	145	180	186	186	186	151	93	40	5
12-month Total =														1292	1443	1558	1599	1587	1540

Note: (1) 7 hours of equipment operation during 10 hrs/day of construction activity.

#### Notes - Combustion Emissions

(1) For Construction Equipment

For Diesel construction equipment, emission factors based on equipment meeting EPA Tier I off-road Diesel standards and use of CARB ultra low-sulfur fuel.

For trucks, depending on size of truck, emissions factors based on EMFAC 2002 v.2.2 for heavy-heavy duty or medium duty Diesel trucks, fleet average for calendar year 2005.

(2) For Delivery Trucks

From EMFAC 2002 V.2.2, heavy-heavy duty Diesel trucks, fleet average for calendar year 2005, San Francisco Air Basin.

(3) For Worker Travel

From EMFAC 2002 v.2.2, average of light duty automobiles and light duty trucks, fleet average for calendar year 2005.

	Emission Factors (1)				
	NOx	CO	VOC	SOx	PM10
Truck Hauling (lbs/vmt)	0.03543	0.02029	0.00264	0.00041	0.00077
Truck Hauling (lbs/1000 gals)	167.27418	95.77071	12.48315	1.93738	3.61512

Notes:

(1) From EMFAC 2002 V.2.2, heavy-heavy duty Diesel trucks, fleet average for calendar year 2005, San Francisco Air Basin.

	Emission Factors				
	NOx	CO	POC	SOx	PM10
Light Duty Trucks/Cars (lbs/vmt)(1)	0.00163	0.01612	0.00160	0.00001	0.00008
Light Duty Trucks (lbs/1000 gals)(2)	41.87820	369.45051	33.92633	0.19942	1.62860
Medium Duty Trucks (lbs/1000 gals)(3)	40.59	262.67	25.01	0.21	1.32

Notes:

(1) From EMFAC 2002 v.2.2, average of light duty automobiles and light duty trucks, fleet average for calendar year 2005, San Francisco Air Basin.

(2) From EMFAC 2002 v.2.2, light duty trucks (gasoline and Diesel), fleet average for calendar year 2005, San Francisco Air Basin.

(3) From EMFAC 2002 v.2.2, medium duty trucks (gasoline and Diesel), fleet average for calendar year 2005, San Francisco Air Basin.

#### Gasoline Equipment Factors - Small Engines

	NOx	CO	(gm/bhp-hr)	SO2	PM10
			POC		
Small Equipment(1) (g/bhp-hr)	2.03	353.00	19.13	0.00	0.06
Small Equipment(1) (lb/1000 gal)	79.44	13813.38	748.58	0.00	2.35

Notes:

(1) From EPA's "Non-road Engine and Vehicle Emission Study Report", 11/91, Table 2-07, for generator sets, welders, pumps, and air compressors less than 50 hp.

Worker Travel Daily Emissions (Maximum Monthly)														
Number of Workers Per Day(1)	Average Vehicle Occupancy (person/veh.)	Number of Round Trips Per Day	Average Round Trip Haul Distance (Miles)	Vehicle Miles Traveled Per Day (Miles)	Emission Factors (lbs/vmt)(1)					Daily Emissions (lbs/day)				
					NOx	CO	POC	SOx	PM10	NOx	CO	POC	SOx	PM10
250	1.3	192	70	13462	0.0016	0.0161	0.0016	0.0000	0.0001	21.99	216.95	21.56	0.12	1.03

Notes:

(1) See notes for combustion emissions.

Worker Travel Annual Emissions															
Average Number of Workers Per Day	Average Vehicle Occupancy (person/veh.)	Number of Round Trips Per Day	Average Round Trip Haul Distance (Miles)	Days per Year	Vehicle Miles Traveled Per Year	Emission Factors (lbs/vmt)(1)					Annual Emissions (tons/yr)				
						NOx	CO	POC	SOx	PM10	NOx	CO	POC	SOx	PM10
157	1.3	121	70	240	2,025,692	0.0016	0.0161	0.0016	0.0000	0.0001	1.65	16.32	1.62	0.01	0.08

Notes:

(1) See notes for combustion emissions.

Delivery Truck Daily Emissions (Maximum Monthly)												
Number of Deliveries Per Day(1)	Average Round Trip Haul Distance (miles)	Vehicle Miles Traveled Per Day	Emission Factors (lbs/vmt)(1)					Daily Emissions (lbs/day)				
			NOx	CO	POC	SOx	PM10	NOx	CO	POC	SOx	PM10
26	70	1820	0.0354	0.0203	0.0026	0.0004	0.0008	64.49	36.92	4.81	0.75	1.39
Idle exhaust (2)												0.1092

Notes:

(1) See notes for combustion emissions.

(2) 26 trucks per day times 1 hr idle time per visit times 0.0042 lb/hr.

Delivery Truck Annual Emissions												
Average Number of Deliveries Per Year	Average Round Trip Haul Distance (miles)	Vehicle Miles Traveled Per Year	Emission Factors (lbs/vmt)(1)					Annual Emissions (tons/yr)				
			NOx	CO	POC	SOx	PM10	NOx	CO	POC	SOx	PM10
2400	70	168000.00	0.0354	0.0203	0.0026	0.0004	0.0008	2.98	1.70	0.22	0.03	0.06
Idle exhaust (2,3)												0.00504

Notes:

(1) See notes for combustion emissions.

(2) Annual average of 10 trucks per day, 240 days per year times 1 hr idle time per visit times 0.0042 lb/hr

(3) Based on 1.91 g/hr idle emission rate for the composite HDD truck fleet in 2001 from EPA's PART5 model.

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 Area : San Francisco Air Basin Average  
 I/M Stat : I and M program in effect  
 Emissions: Tons Per Day

	LDA-NCAT	LDA-CAT	LDA-DSL	LDA-TOT	LDT1-NCAT	LDT1-CAT	LDT1-DSL	LDT1-TOT	LDT2-NCAT	LDT2-CAT	LDT2-DSL
Vehicles	67414	2972660	15394	3055470	23488	580582	14396	618465	12480	711733	8207
VMOT/1000	790	100533	324	101647	410	19137	402	19949	224	24540	284
Trips	287679	18757200	88176	19133100	101829	3639110	88494	3829430	55412	4517670	51784
Reactive Organic Gas Emissions											
Run Exh	4.9	16.99	0.09	21.99	2.52	4.44	0.07	7.03	1.33	4.66	0.03
Idle Exh	0	0	0	0	0	0	0	0	0	0	0
Start Ex	1.72	21.34	0	23.06	0.59	4.53	0	5.12	0.3	5.43	0
Total Ex	6.62	38.33	0.09	45.05	3.11	8.97	0.07	12.15	1.63	10.09	0.03
Diurnal	0.39	3.12	0	3.51	0.13	0.72	0	0.85	0.07	0.63	0
Hot Soak	0.9	2.72	0	3.61	0.32	0.66	0	0.98	0.17	0.57	0
Running	5.65	17.42	0	23.06	1.25	5.85	0	7.11	0.55	5.37	0
Resting	0.19	1.16	0	1.35	0.07	0.29	0	0.35	0.03	0.23	0
Total	13.74	62.75	0.09	76.58	4.87	16.5	0.07	21.44	2.46	16.9	0.03
Carbon Monoxide Emissions											
Run Exh	63.55	439.06	0.28	502.89	33.49	134.92	0.3	168.71	17.89	132.33	0.17
Idle Exh	0	0	0	0	0	0	0	0	0	0	0
Start Ex	9.55	224.61	0	234.16	3.44	58.78	0	62.21	1.84	61.47	0
Total Ex	73.1	663.67	0.28	737.05	36.93	193.7	0.3	230.93	19.73	193.79	0.17
Oxides of Nitrogen Emissions											
Run Exh	4	51.66	0.49	56.15	2.04	15.7	0.56	18.31	1.09	22.43	0.42
Idle Exh	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.46	12.77	0	13.23	0.16	2.74	0	2.9	0.09	5.16	0
Total Ex	4.46	64.43	0.49	69.37	2.2	18.45	0.56	21.21	1.18	27.59	0.42
Carbon Dioxide Emissions (000)											
Run Exh	0.43	40.37	0.13	40.93	0.22	9.32	0.15	9.7	0.12	11.99	0.11
Idle Exh	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0.06	1.55	0	1.61	0.02	0.36	0	0.39	0.01	0.45	0
Total Ex	0.49	41.92	0.13	42.54	0.24	9.68	0.15	10.08	0.13	12.44	0.11
PM10 Emissions											
Run Exh	0.03	1.12	0.05	1.2	0.01	0.23	0.03	0.28	0.01	0.55	0.02
Idle Exh	0	0	0	0	0	0	0	0	0	0	0
Start Ex	0	0.13	0	0.14	0	0.03	0	0.03	0	0.06	0
Total Ex	0.03	1.25	0.05	1.34	0.02	0.26	0.03	0.31	0.01	0.61	0.02
TireWear	0.01	0.89	0	0.9	0	0.17	0	0.18	0	0.22	0
BrakeWr	0.01	1.39	0	1.41	0.01	0.26	0.01	0.28	0	0.34	0
Total	0.05	3.53	0.06	3.64	0.02	0.69	0.04	0.76	0.01	1.16	0.02
Lead	0	0	0	0	0	0	0	0	0	0	0
SOx	0.01	0.41	0.01	0.43	0	0.1	0.01	0.11	0	0.12	0.01
Fuel Consumption (000 gallons)											
Gasoline	63.96	4411.67	0	4475.63	31.81	1025.72	0	1057.53	17.29	1308.48	0
Diesel	0	0	11.73	11.73	0	0	13.89	13.89	0	0	9.79

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Area : San Francisco Air Basin Average  
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Emissions: Tons Per Day

	LDT2-TOT	MDV-NCAT	MDV-CAT	MDV-DSL	MDV-TOT	LHDT1-NC/LHDT1-CA1	LHDT1-DSL	LHDT1-TOT	LHDT2-NC/LHDT2-CA1	LHDT2-DSL	LHDT2-TOT	MHDT-NC	MHDT-CAT	MHDT-DSL	MHDT-TOT	HHDT-NC	HHDT-CAT	HHDT-DSL		
Vehicles	732420	5615	363369	11141	380125	1438	34381	6749	42569	7	8851	6875	15733	2194	10708	36009	48912	438	3084	28936
VMT/1000	25048	103	12439	409	12952	12	1977	457	2446	0	437	361	798	19	483	2180	2681	6	260	4462
Trips	4624860	25852	2304600	71509	2401960	47566	1136880	84893	1269340	227	292681	86478	379386	100213	489018	1009700	1598930	20018	140854	146430
Reactive Org																				
Run Exh	6.02	0.71	3.18	0.04	3.93	0.1	0.46	0.18	0.74	0	0.26	0.19	0.45	0.14	0.4	0.82	1.36	0.1	0.91	3.31
Idle Exh	0	0	0	0	0	0	0.05	0	0.05	0	0.01	0	0.01	0	0.02	0.02	0.05	0	0	0.24
Start Ex	5.73	0.17	3.67	0	3.84	0.4	0.69	0	1.08	0	0.29	0	0.29	1.24	0.93	0	2.17	0.42	0.72	0
Total Ex	11.76	0.88	6.84	0.04	7.76	0.5	1.2	0.18	1.88	0	0.56	0.19	0.75	1.38	1.36	0.83	3.58	0.51	1.63	3.55
Diurnal	0.7	0.02	0.34	0	0.36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hot Soak	0.75	0.05	0.33	0	0.39	0.04	0.05	0	0.09	0	0.03	0	0.03	0.05	0.04	0	0.09	0.01	0.02	0
Running	5.92	0.17	2.89	0	3.07	0.33	0.8	0	1.13	0	0.49	0	0.49	0.46	0.94	0	1.4	0.11	0.42	0
Resting	0.27	0.01	0.13	0	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	19.39	1.14	10.55	0.04	11.72	0.87	2.04	0.18	3.1	0	1.07	0.19	1.27	1.89	2.35	0.83	5.07	0.64	2.07	3.55
Carbon Mon																				
Run Exh	150.39	12.71	71.01	0.23	83.95	2.01	5.26	0.58	7.85	0.01	3.4	0.56	3.97	3.32	7.03	5.27	15.61	3.35	12.88	13.28
Idle Exh	0	0	0	0	0	0.01	0.3	0.01	0.32	0	0.08	0.01	0.08	0.03	0.15	0.1	0.28	0	0	1.42
Start Ex	63.31	1.32	37.82	0	39.14	2.24	8.86	0	11.1	0.01	3.9	0	3.91	7.08	16.68	0	23.76	5.79	11.23	0
Total Ex	213.7	14.04	108.83	0.23	123.09	4.27	14.42	0.58	19.27	0.02	7.38	0.57	7.96	10.43	23.85	5.37	39.65	9.13	24.12	14.7
Oxides of Ni																				
Run Exh	23.94	0.71	14.69	0.62	16.02	0.03	0.92	2.92	3.87	0	0.52	2.45	2.97	0.08	1.86	26.82	28.76	0.15	4.09	73.67
Idle Exh	0	0	0	0	0	0	0	0.02	0.02	0	0	0.02	0.02	0	0	0.31	0.31	0	0	4.34
Start Ex	5.25	0.06	2.95	0	3	0.04	1.65	0	1.69	0	0.6	0	0.6	0.12	1.67	0	1.79	0.1	1.41	0
Total Ex	29.19	0.76	17.64	0.62	19.02	0.07	2.58	2.94	5.59	0	1.12	2.47	3.59	0.2	3.53	27.13	30.86	0.24	5.5	78.01
Carbon Diox																				
Run Exh	12.22	0.06	8.41	0.16	8.63	0.01	2.11	0.26	2.39	0	0.47	0.22	0.68	0.01	0.36	3.62	4	0	0.17	10.63
Idle Exh	0	0	0	0	0	0	0.01	0	0.01	0	0	0	0	0	0	0.02	0.02	0	0	0.22
Start Ex	0.46	0.01	0.32	0	0.32	0.01	0.05	0	0.06	0	0.01	0	0.01	0.02	0.02	0	0.04	0	0.01	0
Total Ex	12.68	0.07	8.73	0.16	8.95	0.02	2.17	0.26	2.46	0	0.48	0.22	0.7	0.04	0.39	3.63	4.06	0.01	0.17	10.85
PM10 Emiss																				
Run Exh	0.57	0	0.27	0.02	0.3	0	0.02	0.04	0.06	0	0.01	0.04	0.05	0	0.01	0.78	0.79	0	0	1.46
Idle Exh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0.1
Start Ex	0.06	0	0.03	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Ex	0.63	0	0.3	0.02	0.33	0	0.03	0.04	0.06	0	0.01	0.04	0.05	0	0.01	0.79	0.8	0	0.01	1.56
TireWear																				
BrakeWr	0.22	0	0.11	0	0.11	0	0.03	0.01	0.03	0	0.01	0	0.01	0	0.01	0.03	0.04	0	0	0.18
	0.35	0	0.17	0.01	0.18	0	0.03	0.01	0.03	0	0.01	0	0.01	0	0.01	0.03	0.04	0	0	0.06
Total	1.2	0.01	0.59	0.03	0.62	0	0.08	0.05	0.13	0	0.02	0.05	0.07	0	0.02	0.85	0.87	0	0.01	1.8
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0.13	0	0.09	0.01	0.1	0	0.02	0.02	0.04	0	0	0.02	0.02	0	0	0.32	0.33	0	0	0.97
Fuel Consur																				
Gasoline	1325.77	9.72	913.43	0	923.15	3.28	224.71	0	227.99	0.02	50.63	0	50.65	5.95	44.13	0	50.08	2.46	22.01	0
Diesel	9.79	0	0	14.07	14.07	0	0	23.79	23.79	0	0	19.53	19.53	0	0	326.88	326.88	0	0	976.88

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	HHDT-TOT	LHV-NCAT	LHV-CAT	LHV-DSL	LHV-TOT	SBUS-NCA	SBUS-CAT	SBUS-DSL	SBUS-TOT	UB-NCAT	UB-CAT	UB-DSL	UB-TOT	MH-NCAT	MH-CAT	MH-DSL	MH-TOT	MCY-NCAT	MCY-CAT	MCY-DSL	MCY-TOT	ALL-TOT
Vehicles	32458	0	0	0	0	141	671	4354	5167	233	2412	5089	7734	4722	37360	2432	44513	64415	11530	0	75945	5059510
VMT/1000	4727	0	0	0	0	6	28	177	210	28	296	621	945	58	515	35	607	467	103	0	570	172581
Trips	307302	0	0	0	0	565	2685	17416	20666	931	9648	20357	30936	472	3737	243	4453	128818	23057	0	151875	33752200
Reactive Org																						
Run Exh	4.32	0	0	0	0	0.05	0.05	0.08	0.19	0.29	0.74	0.74	1.77	0.41	0.4	0.01	0.82	2.02	0.21	0	2.23	50.84
Idle Exh	0.24	0	0	0	0	0	0.01	0.01	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0.37
Start Ex	1.14	0	0	0	0	0.01	0.01	0	0.02	0.02	0.05	0	0.06	0.01	0.01	0	0.01	0.4	0.07	0	0.47	42.99
Total Ex	5.69	0	0	0	0	0.06	0.07	0.09	0.23	0.31	0.79	0.74	1.84	0.42	0.41	0.01	0.83	2.43	0.27	0	2.7	94.2
Diurnal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0.01	0.09	0.07	0	0.16	5.61
Hot Soak	0.03	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0.1	0.02	0	0.11	6.09
Running	0.53	0	0	0	0	0.01	0.01	0	0.02	0.02	0.02	0	0.04	0	0.01	0	0.01	0.64	0.14	0	0.78	43.56
Resting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04	0.02	0	0.06	2.17
Total Ex	6.25	0	0	0	0	0.07	0.09	0.09	0.25	0.33	0.82	0.74	1.88	0.42	0.43	0.01	0.85	3.3	0.52	0	3.82	151.63
Carbon Mon																						
Run Exh	29.51	0	0	0	0	1.14	0.81	0.52	2.47	5.9	5.59	3	14.49	10.06	12.29	0.05	22.4	26.58	2.83	0	29.41	1031.65
Idle Exh	1.42	0	0	0	0	0.01	0.06	0.07	0.13	0	0	0	0	0	0	0	0	0	0	0	0	2.23
Start Ex	17.02	0	0	0	0	0.06	0.19	0	0.25	0.09	0.79	0	0.88	0.03	0.13	0	0.16	1.18	0.47	0	1.65	457.55
Total Ex	47.95	0	0	0	0	1.21	1.05	0.59	2.85	5.99	6.37	3	15.36	10.09	12.42	0.05	22.56	27.76	3.3	0	31.07	1491.43
Oxides of Ni																						
Run Exh	77.9	0	0	0	0	0.02	0.12	2.33	2.47	0.12	1.38	15.73	17.24	0.23	1.46	0.43	2.12	0.69	0.16	0	0.85	250.59
Idle Exh	4.34	0	0	0	0	0	0	0.21	0.21	0	0	0	0	0	0	0	0	0	0	0	0	4.91
Start Ex	1.51	0	0	0	0	0	0.01	0	0.01	0	0.07	0	0.08	0	0.01	0	0.01	0.05	0	0	0.05	30.12
Total Ex	83.75	0	0	0	0	0.02	0.13	2.54	2.69	0.12	1.46	15.73	17.31	0.24	1.46	0.43	2.13	0.74	0.16	0	0.9	285.62
Carbon Diox																						
Run Exh	10.8	0	0	0	0	0	0.02	0.29	0.32	0.02	0.24	1.91	2.17	0.04	0.39	0.06	0.49	0.06	0.01	0	0.07	92.4
Idle Exh	0.22	0	0	0	0	0	0	0.01	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0.27
Start Ex	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0.01	2.91
Total Ex	11.03	0	0	0	0	0.01	0.02	0.3	0.33	0.02	0.24	1.91	2.18	0.04	0.39	0.06	0.49	0.06	0.02	0	0.08	95.58
PM10 Emiss																						
Run Exh	1.46	0	0	0	0	0	0	0.09	0.09	0	0.01	0.29	0.3	0	0	0.01	0.01	0.03	0	0	0.03	5.14
Idle Exh	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.11
Start Ex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.27
Total Ex	1.56	0	0	0	0	0	0	0.09	0.09	0	0.01	0.29	0.3	0	0	0.01	0.01	0.03	0	0	0.03	5.52
TireWear	0.18	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0.01	0	0.01	0	0	0	0	1.69
BrakeWr	0.07	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0.01	0	0.01	0.01	0	0	0.01	2.39
Total	1.81	0	0	0	0	0	0	0.1	0.1	0	0.01	0.31	0.32	0	0.02	0.01	0.03	0.04	0	0	0.04	9.6
Lead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOx	0.97	0	0	0	0	0	0	0.03	0.03	0	0	0.17	0.17	0	0	0.01	0.01	0	0	0	0	2.36
Fuel Consur																						
Gasoline	24.47	0	0	0	0	0.75	2.75	0	3.5	3.47	26.3	0	29.78	6.23	41.94	0	48.18	11.92	2.2	0	14.11	8230.84
Diesel	976.88	0	0	0	0	0	0	27.3	27.3	0	0	171.69	171.69	0	0	5.18	5.18	0	0	0	0	1600.74

Onsite Combustion Emissions

Base Factors g/bhp, if Tier 1 >50 hp (1)									Appendix A Table A3 Adjustment (2)						Adjustment (3)	Adjusted Factors						
Equipment	HP Cat.	Tier	BSFC lb/h	NOx	CO	VOC	SOx	PM10	Adj. Type	NOx	CO	VOC	SOx	PM10	PM10 Fuel S	BSFC	NOx	CO	VOC	SOx	PM10	
Crane	175-300	1	0.367	5.5772	0.7475	0.3085	0.00499	0.2521	None	1	1	1	1	1	1	-0.086	0.367	5.58	0.75	0.31	0.0049	0.17
Wrecking Ball	175-300	1	0.367	5.5772	0.7475	0.3085	0.00499	0.2521	None	1	1	1	1	1	1	-0.086	0.367	5.58	0.75	0.31	0.0049	0.17
Dozer	100-175	1	0.367	5.6523	0.8667	0.3384	0.00499	0.2799	Hi LF	0.95	1.53	1.05	1.01	1.23	1.23	-0.087	0.371	5.37	1.33	0.36	0.0049	0.26
Scraper	175-300	1	0.367	5.5772	0.7475	0.3085	0.00499	0.2521	Hi LF	0.95	1.53	1.05	1.01	1.23	1.23	-0.087	0.371	5.30	1.14	0.32	0.0049	0.22
Grader	100-175	1	0.367	5.6523	0.8667	0.3384	0.00499	0.2799	Hi LF	0.95	1.53	1.05	1.01	1.23	1.23	-0.087	0.371	5.37	1.33	0.36	0.0049	0.26
Backhoe	50-100	1	0.408	5.5988	2.3655	0.5213	0.00555	0.473	Lo LF	1.1	2.57	2.29	1.18	1.97	1.97	-0.113	0.481	6.16	6.08	1.19	0.0064	0.82
Loader	50-100	1	0.408	5.5988	2.3655	0.5213	0.00555	0.473	Hi LF	0.95	1.53	1.05	1.01	1.23	1.23	-0.096	0.412	5.32	3.62	0.55	0.0055	0.49
Truck- Water	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad
Forklift	50-100	1	0.408	5.5988	2.3655	0.5213	0.00555	0.473	Hi LF	0.95	1.53	1.05	1.01	1.23	1.23	-0.096	0.412	5.32	3.62	0.55	0.0055	0.49
Dump Truck	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad
Service Truck	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad
Boom Truck	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad
Truck- Fuel/Lube	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad
Concrete Pumper Truck	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad
Trucks- Pickup 3/4 ton	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad
Light Plants	25-50	0	0.408	6.9	5	1.8	0.00555	0.8	None	1	1	1	1	1	1	-0.094	0.40	6.90	5.00	1.80	0.0053	0.71
Air Compressor	25-50	0	0.408	6.9	5	1.8	0.00555	0.8	None	1	1	1	1	1	1	-0.094	0.40	6.90	5.00	1.80	0.0053	0.71

Adjusted factors lbs/gallon (4)							Total Daily Daily Fuel Use(5) Emissions Lbs/day (Gals/day)							Total Annual Annual Fuel Use(6) Emissions Lbs/yr (Gals/yr)						
Equipment	Tier		NOx	CO	VOC	SOx	PM10		NOx	CO	VOC	SOx	PM10		NOx	CO	VOC	SOx	PM10	
Crane	1		237.87	31.88	13.16	0.21	7.09	70.00	16.65	2.23	0.92	0.01	0.50	7,700	1831.58	245.48	101.31	1.60	54.60	
Wrecking Ball	1		237.87	31.88	13.16	0.21	7.09	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	
Dozer	1		226.75	56.00	15.00	0.21	10.88	0.00	0.00	0.00	0.00	0.00	0.00	1,540	349.19	86.23	23.11	0.32	16.75	
Scraper	1		223.74	48.29	13.68	0.21	9.43	0.00	0.00	0.00	0.00	0.00	0.00	1,260	281.91	60.85	17.24	0.26	11.88	
Grader	1		226.75	56.00	15.00	0.21	10.88	0.00	0.00	0.00	0.00	0.00	0.00	2,100	476.17	117.59	31.51	0.44	22.84	
Backhoe	1		200.23	197.65	38.81	0.21	26.63	52.50	10.51	10.38	2.04	0.01	1.40	8,050	1611.86	1591.09	312.44	1.67	214.40	
Loader	1		202.03	137.47	20.79	0.21	18.44	0.00	0.00	0.00	0.00	0.00	0.00	2,100	424.27	288.69	43.66	0.44	38.72	
Truck- Water	na		167.27	95.77	12.48	0.21	3.62	0.00	0.00	0.00	0.00	0.00	0.00	3,067	513.10	293.77	38.29	0.64	11.09	
Forklift	1		202.03	137.47	20.79	0.21	18.44	52.50	10.61	7.22	1.09	0.01	0.97	7,700	1555.65	1058.54	160.09	1.60	141.97	
Dump Truck	na		167.27	95.77	12.48	0.21	3.62	0.00	0.00	0.00	0.00	0.00	0.00	6,573	1099.49	629.50	82.05	1.38	23.76	
Service Truck	na		74.40	59.47	5.57	0.21	4.83	10.92	0.81	0.65	0.06	0.00	0.05	3,931	292.50	233.77	21.88	0.83	19.00	
Boom Truck	na		167.27	95.77	12.48	0.21	3.62	10.92	1.83	1.05	0.14	0.00	0.04	1,529	255.73	146.41	19.08	0.32	5.53	
Truck- Fuel/Lube	na		167.27	95.77	12.48	0.21	3.62	21.91	3.66	2.10	0.27	0.00	0.08	4,382	733.00	419.67	54.70	0.92	15.84	
Concrete Pumper Truck	na		167.27	95.77	12.48	0.21	3.62	21.91	3.66	2.10	0.27	0.00	0.08	3,944	659.70	377.70	49.23	0.83	14.26	
Trucks- Pickup 3/4 ton	na		41.88	369.45	33.93	0.20	1.63	10.92	0.46	4.03	0.37	0.00	0.02	1,529	64.02	564.82	51.87	0.30	2.49	
Light Plants	0		270.01	195.66	70.44	0.21	27.64	8.89	2.40	1.74	0.63	0.00	0.25	1,778	480.07	347.88	125.24	0.37	49.15	
Air Compressor	0		270.01	195.66	70.44	0.21	27.64	8.89	2.40	1.74	0.63	0.00	0.25	1,778	480.07	347.88	125.24	0.37	49.15	
Total =							269.36	53.00	33.23	6.42	0.06	3.62	58,961.00	11,108.32	5.55	6,809.88	1,256.93	12.28	691.42	
															5.55	3.40	0.63	0.01	0.35 tons/yr	

(1) - Steady State Emission Factors from Table A2 of EPA November 2002 NR-009b Publication.

(2) - In use adjustment factors per Table A3 EPA November 2002 NR-009b Publication.

(3) - PM10 and SO2 adjustments due to Equation 5 and Equation 7 on pages 18 and 19, Respectively of EPA Report No. NR-009b

(4) - Calculation uses adjusted BSFC and assumed 7.1 lbs/gallon. The onroad emission factors are not adjusted.

(5) - Daily fuel use based on peak combustion month equipment schedule.

(6) - Annual fuel use based on average level during peak 12-month period.

Construction Equipment Daily Fuel Use (peak period)					
Equipment	Gasoline/ Diesel	Number of Units	Hrs/Day Per Unit	Gals/Hr Per Unit	Total Fuel Use (Gals/day)
Grader	D	0	7	5.00	0.00
Dozer	D	0	7	5.50	0.00
Scraper	D	0	7	9.00	0.00
Forklift	D	3	7	2.50	52.50
Backhoe	D	3	7	2.50	52.50
Crane	D	2	7	5.00	70.00
Loader	D	0	7	2.50	0.00
Field truck (3/4T)	D	2	7	0.78	10.92
Wrecking Ball	D	0	7	5.00	0.00
Dump truck	D	0	7	3.13	0.00
Water truck	D	0	7	3.13	0.00
Service truck	D	1	7	1.56	10.92
Fuel Truck	D	1	7	3.13	21.91
Boom truck	D	1	7	1.56	10.92
Concrete pump	D	1	7	3.13	21.91
Port air compressor	D	1	7	1.27	8.89
Port. Light plant	D	1	7	1.27	8.89

Total =

269.36

Construction Equipment Annual Fuel Use (peak 12-month period)								
Equipment	Gasoline/ Diesel	17-Month Average Number of Units Per Year(1)	Peak 12- Month Average Number of Units Per Year(1)	Average Operating Hrs/Day Per Unit	Gals/Hr Per Unit	Average Operating Days per Year	17-Month Average Total Fuel Use (Gals/yr)	Peak 12-Month Average Total Fuel Use (Gals/yr)
Grader	D	0.18	0.25	7	5.00	240	1,482	2,100
Dozer	D	0.12	0.17	7	5.50	240	1,087	1,540
Scraper	D	0.06	0.08	7	9.00	240	889	1,260
Forklift	D	1.41	1.83	7	2.50	240	5,929	7,700
Backhoe	D	1.35	1.92	7	2.50	240	5,682	8,050
Crane	D	0.65	0.92	7	5.00	240	5,435	7,700
Loader	D	0.76	0.50	7	2.50	240	3,212	2,100
Field truck (3/4T)	D	0.94	1.17	7	0.78	240	1,233	1,529
Wrecking Ball	D	0.12	0.00	7	5.00	240	988	0
Dump truck	D	1.59	1.25	7	3.13	240	8,352	6,573
Water truck	D	0.59	0.58	7	3.13	240	3,093	3,067
Service truck	D	1.06	1.50	7	1.56	240	2,775	3,931
Fuel Truck	D	0.59	0.83	7	3.13	240	3,093	4,382
Boom truck	D	0.41	0.58	7	1.56	240	1,079	1,529
Concrete pump	D	0.53	0.75	7	3.13	240	2,784	3,944
Port air compressor	D	0.59	0.83	7	1.27	240	1,255	1,778
Port. Light plant	D	0.59	0.83	7	1.27	240	1,255	1,778

Total =

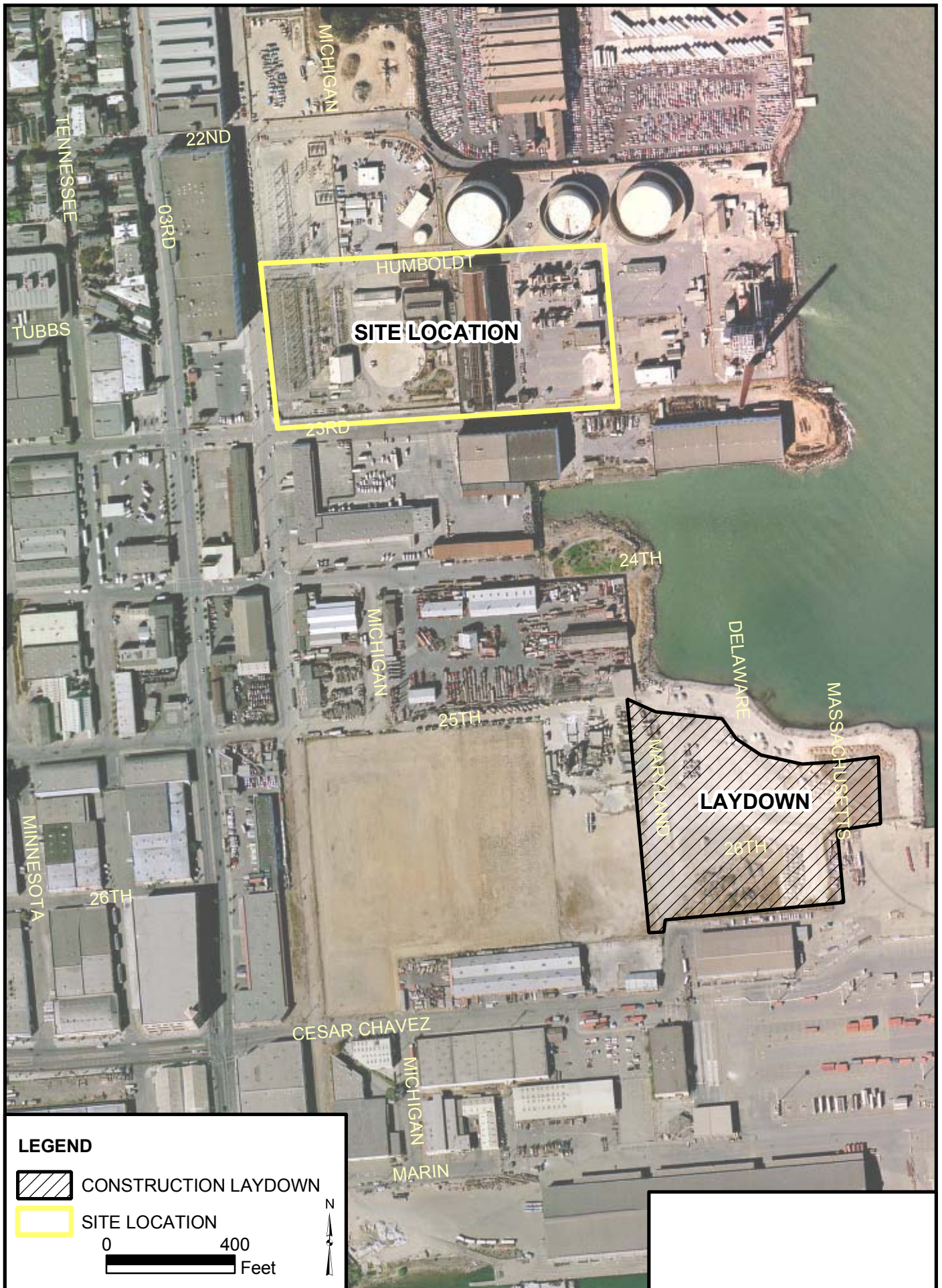
49,625

58,961

**SFERC - Construction Modeling**

Short Term Impacts (24 hours and less)				
	NOx	CO	SOx	PM10
Combustion (lbs/day)	53.0	33.2	0.06	3.73
Construction Dust (lbs/day)				15.98
Windblown Dust (lbs/day)				0.75

Long Term Impacts (annual)				
	NOx	CO	SOx	PM10
Combustion (tons/yr)	5.55	3.40	0.01	0.35
Construction Dust (tons/yr)				1.40
Windblown Dust (tons/yr)				0.10



**Pipeline Construction - Combustion Emissions**

Base Factors g/bhp, if Tier 1 >50 hp (1)									Appendix A Table A3 Adjustment (2)						Adjustment (3)	Adjusted Factors					
Equipment	HP Cat.	Tier	BSFC lb/hp-hr	NOx	CO	VOC	SOx	PM10	Adj. Type	NOx	CO	VOC	SOx	PM10	PM10 Fuel	BSFC	NOx	CO	VOC	SOx	PM10
Excavator	175-300	1	0.367	5.5772	0.7475	0.3085	0.00499	0.2521	Hi LF	0.95	1.53	1.05	1.01	1.23	-0.087	0.371	5.30	1.14	0.32	0.0049	0.22
Roller	100-175	1	0.367	5.6523	0.8667	0.3384	0.00499	0.2799	Hi LF	0.95	1.53	1.05	1.01	1.23	-0.087	0.371	5.37	1.33	0.36	0.0049	0.26
Water Truck	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad
Service Truck	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad
Trucks- Pickup	Onroad	na	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad	Onroad

Adjusted factors lbs/1000 gallon (4)							Total Daily Daily Fuel Use(5) Emissions Lbs/day (Gals/day)				
Equipment	Tier	NOx	CO	VOC	SOx	PM10	NOx	CO	VOC	SOx	PM10
Excavator	1	223.74	48.29	13.68	0.21	9.43	38.50	8.61	1.86	0.53	0.01
Roller	1	226.75	56.00	15.00	0.21	10.88	17.50	3.97	0.98	0.26	0.00
Water Truck	na	167.27	95.77	12.48	1.94	3.62	21.91	3.66	2.10	0.27	0.04
Service Truck	na	74.40	59.47	5.57	0.21	4.83	10.92	0.81	0.65	0.06	0.00
Trucks- Pickup	na	41.88	369.45	33.93	0.20	1.63	5.46	0.23	2.02	0.19	0.00

Total = 94.29 17.29 7.60 1.31 0.06 0.69

- (1) - Steady State Emission Factors from Table A2 of EPA November 2002 NR-009b Publication.  
(2) - In use adjustment factors per Table A3 EPA November 2002 NR-009b Publication.  
(3) - PM10 and SO2 adjustments due to Equation 5 and Equation 7 on pages 18 and 19, Respectively of EPA Report No. NR-009b  
(4) - Calculation uses adjusted BSFC and assumed 7.1 lbs/gallon. The onroad emission factors are not adjusted.  
(5) - Based on 7 hrs/day of equipment operation.

Pipeline Construction - Daily Fugitive Dust Emissions									
Equipment	Number of Units	Daily Process Rate Per Unit	Total Process Rate	Units	PM2.5 Emission Factor(1) (lbs/unit)	PM10 Emission Factor(1) (lbs/unit)	Control Factor(1) (%)	PM2.5 Emissions (lbs/day)	PM10 Emissions (lbs/day)
Excavator	1	662	662	tons	2.82661E-05	8.99E-05	0%	0.02	0.06
Pickup Truck Unpaved Road Travel	1	0.9	0.9	vmt	0.15	0.99	92%	0.01	0.07
Service Truck Unpaved Road Travel	1	0.9	0.9	vmt	0.22	1.43	92%	0.02	0.11
Water Truck Unpaved Road Travel	1	0.9	0.9	vmt	0.44	2.84	92%	0.03	0.21
Windblown Dust (active construction area)	N/A	5,000	5,000	sq.ft.	6.72783E-06	1.68E-05	92%	0.00	0.01
Total =								0.08	0.45

Notes:

(1) See notes for fugitive dust emission calculations.

Pipeline Construction - Delivery Truck Daily Emissions												
Number of Deliveries Per Day(1)	Average Round Trip Haul Distance (miles)	Vehicle Miles Traveled Per Day	Emission Factors (lbs/vmt)(1)					Daily Emissions (lbs/day)				
			NOx	CO	POC	SOx	PM10	NOx	CO	POC	SOx	PM10
7	70	490	0.0354	0.0203	0.0026	0.0004	0.0008	17.36	9.94	1.30	0.20	0.38
Idle exhaust (2)												0.0294

Notes:

(1) See notes for combustion emissions.

(2) 7 trucks per day times 1 hr idle time per visit times 0.0042 lb/hr.

Pipeline Construction - Worker Travel Daily Emissions														
Number of Workers Per Day(1)	Average Vehicle Occupancy (person/veh.)	Number of Round Trips Per Day	Average Round Trip Haul Distance (Miles)	Vehicle Miles Traveled Per Day (Miles)	Emission Factors (lbs/vmt)(1)					Daily Emissions (lbs/day)				
					NOx	CO	POC	SOx	PM10	NOx	CO	POC	SOx	PM10
15	1.3	12	70	808	0.0016	0.0161	0.0016	0.0000	0.0001	1.32	13.02	1.29	0.01	0.06

Notes:

(1) See notes for combustion emissions.

Daily Pipeline Construction Emissions						
(lbs/day)						
	NOx	CO	VOC	SOx	PM2.5	PM10
Onsite						
Construction Equipment	17.29	7.60	1.31	0.06	0.69	0.69
Fugitive Dust					0.08	0.45
Subtotal =	17.29	7.60	1.31	0.06	0.78	1.15
Offsite						
Worker Travel	1.32	13.02	1.29	0.01	0.06	0.06
Truck Deliveries	17.36	9.94	1.30	0.20	0.38	0.38
Subtotal =	18.68	22.96	2.59	0.21	0.44	0.44
Total =	35.97	30.56	3.90	0.27	1.21	1.59

APPENDIX 8.1E

## Evaluation of Best Available Control Technology

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## **APPENDIX 8.1E**

### **EVALUATION OF BEST AVAILABLE CONTROL TECHNOLOGY**

Rule 2-2-301 requires the application of BACT to any new or modified emissions unit if the new unit or modification results in an increase in permitted daily emissions greater than 10 pounds per day. BACT is defined in Rule 2-2-206 as the most stringent emission limitation or control technique of the following:

- 206.1 The most effective emission control device or technique which has been successfully utilized for the type of equipment comprising such a source; or
- 206.2 The most stringent emission limitation achieved by an emission control device or technique for the type of equipment comprising such a source; or
- 206.3 Any emission control device or technique determined to be technologically feasible and cost-effective by the APCO; or
- 206.4 The most effective emission control limitation for the type of equipment comprising such a source which the EPA states, prior to or during the public comment period, is contained in an approved implementation plan of any state, unless the applicant demonstrates to the satisfaction of the APCO that such limitations are not achievable. Under no circumstances shall the emission control required be less stringent than the emission control required by any applicable provision of federal, state or District laws, rules or regulations.

The SFERP will have emissions in excess of 10 lb/day for NO<sub>x</sub>, POC, CO, PM<sub>10</sub>, and SO<sub>x</sub>. Therefore, BACT will be required for these pollutants. The emission rates determined to be BACT for this project are summarized below. The information considered in making these determinations is discussed in detail in the following sections.

- NO<sub>x</sub> emission limit of 2.5 ppmv @ 15% O<sub>2</sub> constitutes BACT for natural gas-fired LM6000 combustion turbines in simple cycle. At a design exhaust NO<sub>x</sub> concentration of 2.5 ppmv at 15% O<sub>2</sub>, the proposed project will comply with the BACT NO<sub>x</sub> emission limit.
- POC emission limit of 2 ppmv @ 15% O<sub>2</sub> constitutes BACT for natural gas-fired simple cycle combustion turbines. At a design exhaust POC concentration of 2 ppmv at 15% O<sub>2</sub>, the proposed modification will comply with the BACT VOC emission limit.
- CO emission limit of 4 ppmv @ 15% O<sub>2</sub> constitutes BACT for natural gas-fired simple cycle combustion turbines. At a design exhaust CO concentration of 4 ppmv at 15% O<sub>2</sub>, the proposed project will comply with the BACT CO emission limit.
- The use of natural gas with an annual average sulfur content of 0.33 grains per 100 scf constitutes BACT for this project. District BACT Guideline 89.1.3 specifies BACT 2 (achieved in practice) for SO<sub>2</sub> for simple cycle gas turbines with an

output rating of > 50 MW as the exclusive use of clean-burning natural gas.

- BACT for PM<sub>10</sub> is the use of natural gas as the fuel source.

### **8.1E.1 Top-Down BACT Analysis for Control of Nitrogen Oxides**

The following “top-down” BACT analysis for NO<sub>x</sub> has been prepared in accordance with EPA’s 1990 Draft New Source Review Workshop Manual. A “top-down” BACT analysis takes into account energy, environmental, economic, and other costs associated with each alternative technology.

#### **8.1E.1.1 Identify All Control Technologies**

The baseline NO<sub>x</sub> emission rate for this analysis is considered to be 75 ppmvd @ 15% O<sub>2</sub>, based on the governing new source performance standard (40 CFR 60 Subpart GG). This emission rate provides the frame of reference for the evaluation of control effectiveness and feasibility. The maximum degree of control, resulting in the minimum emission rate, is a combination of water injection and either selective catalytic reduction or SCONO<sub>x</sub> to achieve a long-term NO<sub>x</sub> limit of approximately 2.0 ppmvd. Several intermediate levels of control are also evaluated.

There are three basic means of controlling NO<sub>x</sub> emissions from combustion turbines: wet combustion controls, dry combustion controls, and post-combustion controls. Wet and dry combustion controls act to reduce the formation of NO<sub>x</sub> during the combustion process, while post-combustion controls remove NO<sub>x</sub> from the exhaust stream. Potential NO<sub>x</sub> control technologies for combustion gas turbines include the following:

##### **Wet combustion controls**

Water injection

Steam injection

##### **Dry combustion controls**

Dry low-NO<sub>x</sub> combustor design

Catalytic combustors (e.g., XONON)

Other combustion modifications

##### **Post-combustion controls**

Selective non-catalytic reduction (SNCR)

##### ***Non-selective catalytic reduction (NSCR)***

Selective catalytic reduction (SCR)

SCONO<sub>x</sub>

#### **8.1E.1.2 Eliminate Technically Infeasible Options**

The performance and technical feasibility of available NO<sub>x</sub> control technologies are discussed in more detail below.

##### **Combustion Modifications**

### *Wet Combustion Controls*

Steam or water injection directly into the turbine combustor is one of the most common NO<sub>x</sub> control techniques for combustion turbines. These wet injection techniques lower the flame temperature in the combustor and thereby reduce thermal NO<sub>x</sub> formation. The water or steam-to-fuel injection ratio is the most significant factor affecting the performance of wet controls. Steam injection techniques can reduce NO<sub>x</sub> emissions in gas-fired turbines to between 15 and 25 ppmv at 15% O<sub>2</sub>; the practical limit of water injection has been demonstrated at approximately 25-42 ppmv @ 15% O<sub>2</sub> before combustor damage becomes significant. Higher diluent:fuel ratios (especially with steam) not only result in greater NO<sub>x</sub> reductions, but also increase emissions of CO and hydrocarbons, reduce turbine efficiency, and may increase turbine maintenance requirements. The principal NO<sub>x</sub> control mechanisms are identical for water and steam injection. Water or steam is injected into the primary combustion chamber to act as a heat sink, lowering the peak flame temperature of combustion and thus lowering the quantity of thermal NO<sub>x</sub> formed. The injected water or steam exits the turbine as part of the exhaust.

Because water has a higher heat absorbing capacity than steam (due to the temperature and to the latent heat of vaporization associated with water), it takes more steam than water to achieve an equivalent level of NO<sub>x</sub> control. Typical steam injection ratios are 0.5 to 2.0 pounds steam per pound fuel; water injection ratios are generally below 1.0 pound water per pound fuel.

Although the lower peak flame temperature has a beneficial effect on NO<sub>x</sub> emissions, it can also reduce combustion efficiency and prevent complete combustion. As a result, CO and VOC emissions increase as water/steam-to-fuel ratios increase. Thus, the higher steam-to-fuel ratio required for NO<sub>x</sub> control will tend to cause higher CO and VOC emissions from steam-injected turbines than from water-injected turbines, due to the kinetic effect of the water molecules interfering with the combustion process. However, steam injection can reduce the heat rate of the turbine so that equivalent power output can be achieved with reduced fuel consumption and reduced SO<sub>2</sub> emission rates.

Water and steam injection have been in use on both oil- and gas-fired combustion turbines in all size ranges for many years, so these NO<sub>x</sub> control technologies are clearly technologically feasible and widely available.

### *Dry Combustion Controls*

Combustion modifications that lower NO<sub>x</sub> emissions without wet injection include lean combustion, reduced combustor residence time, lean premixed combustion, and two-stage rich/lean combustion. Lean combustion uses excess air (greater than stoichiometric air-to-fuel ratio) in the combustor primary combustion zone to cool the flame, thereby reducing the rate of thermal NO<sub>x</sub> formation. Reduced combustor residence times are achieved by introducing dilution air between the combustor and the turbine sooner than with standard combustors. The combustion gases are at high temperatures for a shorter time, which also has the effect of reducing the rate of thermal NO<sub>x</sub> formation.

The most advanced combination of combustion controls for NO<sub>x</sub> is referred to as dry low-NO<sub>x</sub> (DLN) combustors. DLN technology uses lean, premixed combustion to keep

peak combustion temperatures low, thus reducing the formation of thermal NO<sub>x</sub>. This technology is effective in achieving NO<sub>x</sub> emission levels comparable to levels achieved using wet injection without the need for large volumes of purified water and without the increases in CO and VOC emissions that result from wet injection. However, this control technology does not result in lower NO<sub>x</sub> emissions than can be achieved using water injection on the LM6000 combustion turbine.

Catalytic combustors use a catalytic reactor bed mounted within the combustor to burn a very lean fuel-air mixture. This technology has been commercially demonstrated under the trade name XONON in a 1.5 MW natural gas-fired combustion turbine in Santa Clara, California. The technology has also been announced as commercially available for some models of small combustion turbines, generally 10 MW in size and less. The technology has not been announced commercially for the engines used at the SFERP. No turbine vendor, other than General Electric, has indicated the commercial availability of catalytic combustion systems at the present time; therefore, catalytic combustion controls are not available for this specific application and are not discussed further.

#### *Post-Combustion Controls*

SCR is a post-combustion technique that controls both thermal and fuel NO<sub>x</sub> emissions by reducing NO<sub>x</sub> with a reagent (generally ammonia or urea) in the presence of a catalyst to form water and nitrogen. NO<sub>x</sub> conversion is sensitive to exhaust gas temperature, and performance can be limited by contaminants in the exhaust gas that may mask the catalyst (sulfur compounds, particulates, heavy metals, and silica). SCR is used in numerous gas turbine installations throughout the United States, almost exclusively in conjunction with other wet or dry NO<sub>x</sub> combustion controls. SCR requires the consumption of a reagent (ammonia or urea) and requires periodic catalyst replacement. Estimated levels of NO<sub>x</sub> control are in excess of 90%.

Selective non-catalytic reduction (SNCR) involves injection of ammonia or urea with proprietary conditioners into the exhaust gas stream without a catalyst. SNCR technology requires gas temperatures in the range of 1200° to 2000° F and is most commonly used in boilers. The exhaust temperatures for the SFERP gas turbines are in the 800° F range, which is well below the minimum SNCR operating temperature. Some method of exhaust gas reheat, such as additional fuel combustion, would be required to achieve exhaust temperatures compatible with SNCR operations, and this requirement makes SNCR technologically infeasible for this application. Even when technically feasible, SNCR is unlikely to achieve NO<sub>x</sub> reductions in excess of 80%-85%.

Nonselective catalytic reduction (NSCR) uses a catalyst without injected reagents to reduce NO<sub>x</sub> emissions in an exhaust gas stream. NSCR is typically used in automobile exhaust and rich-burn stationary IC engines, and employs a platinum/rhodium catalyst. NSCR is effective only in a stoichiometric or fuel-rich environment where the combustion gas is nearly depleted of oxygen, and this condition does not occur in turbine exhaust where the oxygen concentrations are typically between 14 and 16%. For this reason, NSCR is not technologically feasible for this application.

SCONOX is a proprietary catalytic oxidation and adsorption technology that uses a single catalyst for the control of NO<sub>x</sub>, CO, and VOC emissions. The catalyst is a monolithic design, made from a ceramic substrate with both a proprietary platinum-

based oxidation catalyst and a potassium carbonate adsorption coating. The catalyst simultaneously oxidizes NO to NO<sub>2</sub>, CO to CO<sub>2</sub>, and VOCs to CO<sub>2</sub> and water, while NO<sub>2</sub> is adsorbed onto the catalyst surface where it is chemically converted to and stored as potassium nitrates and nitrites. The SCONOx potassium carbonate layer has a limited adsorption capability and requires regeneration approximately every 12-15 minutes in normal service.<sup>2</sup> Each regeneration cycle requires approximately 3-5 minutes. At any point in time, approximately 20% of the compartments in a SCONOx system would be in regeneration mode, and the remaining 80% of the compartments would be in oxidation/absorption mode.<sup>3</sup>

Regeneration of the adsorption layer requires exposure of the catalyst to hydrogen gas. In practice, this is accomplished by reforming natural gas with high-pressure steam to produce a gas mixture consisting of methane, carbon dioxide, and hydrogen that is passed over the catalyst beds.<sup>4</sup> Initial attempts by the developer of the process to create regeneration gases from natural gas and steam within the SCONOx catalyst bed (internal autothermal regeneration) failed to produce consistent results; this approach was abandoned in favor of the current offering, which uses an external steam-heated reformer that partially reforms the natural gas to produce the gas mixture that is introduced into the catalyst bed.<sup>5</sup> The reformation reaction continues to some extent within the catalyst bed due to the presence of steam and the temperature of the catalyst surface, but some methane and VOCs from the natural gas remain.

Because the active regenerant gas is hydrogen, the regeneration process must be performed in an atmosphere of low oxygen to prevent dilution of the hydrogen. In practice, the oxygen present in the exhaust gas of combustion turbines is excluded from the catalyst bed by dividing the catalyst bed into a number of individual cells or compartments that are equipped with front and rear dampers that are closed at the beginning of each regeneration cycle. Proper regeneration of the SCONOx catalyst system depends upon the proper functioning and sealing of these sets of dampers approximately 4 times per hour so that an adequate concentration of hydrogen can be maintained in each module to accomplish complete regeneration of the catalyst before the dampers are opened and the compartment is placed back in service.

Because the SCONOx catalyst can be “poisoned” or rendered inactive by even the very small amounts of sulfur compounds present in natural gas, a SCOSOx catalyst bed (or “guard bed”) that is intended to remove trace quantities of sulfur-bearing compounds from the exhaust gas stream is installed upstream of the SCONOx catalyst bed. Like the SCONOx catalyst, the SCOSOx catalyst must be regenerated. Regeneration of the two catalyst types occurs at the same time, with the same regeneration gas supply provided to both; however, the sulfur-bearing regeneration gases for the SCOSOx catalyst exit the SCONOx modules separately from the SCONOx regeneration gases to avoid

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<sup>2</sup> Personal communication, ABB Environmental, 1/18/00.

<sup>3</sup> Stone & Webster, “Independent Technical Review – SCONOx Technology and Design Review”, February 2000.

<sup>4</sup> Stone & Webster, op cit

<sup>5</sup> ABB Environmental, op cit

contaminating the SCONOx catalyst beds. Both regeneration gas streams are returned to the gas turbine exhaust stream downstream of the SCONOx module.<sup>6</sup>

The external reformer used to create the regeneration gases is supplied with steam and natural gas. For one F-class turbine, an estimated 15,000 to 20,000 lbs/hr of 600°F steam is required, along with approximately 100 pounds per hour (2.2 MMbtu/hr) of natural gas.<sup>7</sup> These quantities would be expected to be lower for the smaller LM6000 combustion turbines used in this project. To avoid poisoning the reformer catalyst, the natural gas supplied to the reformer passes through an activated carbon filter to remove some of the sulfur-bearing compounds that are added to natural gas to facilitate leak detection.<sup>8</sup>

The regeneration cycle time is expected to be controlled using a feedback system based on NOx emission rates.<sup>9</sup> That is, the higher the NOx emissions are relative to the design level, the shorter the absorption cycle, and regeneration cycles will occur more frequently. This is analogous to the use of feedback systems for controlling reagent (ammonia or urea) flow rates in an SCR system.

Maintenance requirements for SCONOx systems are expected to include periodic replacement of the reformer fuel sulfur carbon unit, periodic replacement of the reformer catalyst, periodic washings of the SCOSOx and SCONOx catalyst beds, and periodic replacement of the SCOSOx and SCONOx catalyst beds. The replacement frequency for the reformer sulfur carbon unit and reformer catalyst is unknown to the applicant at present. The SCOSOx catalyst is expected to require washing several times per year. The lead (upstream) SCONOx catalyst bed is also expected to require washing several times per year, while the trailing (downstream) SCONOx catalyst bed(s) are expected to require washing less frequently. The annual catalyst washing process is expected to take approximately three days for an F-class machine, at an estimated annual cost of \$200,000.<sup>10</sup> For the smaller LM6000 CTG, the time requirement and cost can be estimated to be approximately one-third of this, or one day and \$65,000. The estimated catalyst life is reported to be 7 washings;<sup>11</sup> the guaranteed catalyst life is 3 years.<sup>12</sup>

The adsorption temperature operating range for the SCONOx system is 300°F to 700°F, with an optimal temperature of approximately 600°F.<sup>13</sup> However, regeneration cycles are not initiated unless the catalyst bed temperature is above 450°F to avoid the creation of hydrogen sulfide during the regeneration of the SCOSOx catalyst.<sup>14</sup>

Estimates of control system efficiency vary. ABB Environmental has indicated that the SCONOx system is capable of achieving a 90% reduction in NOx; a 90% reduction in CO, to a level of 2 ppm; and an 80%-85% reduction in VOC emissions.<sup>15</sup> (This VOC

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<sup>6</sup> ABB Environmental, op cit

<sup>7</sup> Ibid

<sup>8</sup> Stone & Webster, op cit

<sup>9</sup> Ibid

<sup>10</sup> Ibid

<sup>11</sup> Ibid

<sup>12</sup> Letter from ABB Alstom Power to Bibb & Associates dated May 5, 2000. (ABB Three Mountain Power or ABB TMP)

<sup>13</sup> Ibid

<sup>14</sup> ABB Environmental, op cit. Stone & Webster, op cit

reduction is not likely to be achieved with low VOC inlet concentrations, in the 1–2 ppm range.<sup>16)</sup> Commercially quoted NO<sub>x</sub> emission rates for the SCONO<sub>x</sub> system range from 2.0 ppm on a 3-hour average basis, representing a 78% reduction,<sup>17</sup> to 1.0 ppm with no averaging period specified (96% reduction).<sup>18</sup> The SCONO<sub>x</sub> system does not control or reduce emissions of sulfur oxides or particulate matter from the combustion device.<sup>19</sup>

The SCONO<sub>x</sub> system has been applied at the Sunlaw Federal Cogeneration Plant in Vernon California since December 1996, and at the Genetics Institute Facility in Massachusetts. The Sunlaw facility uses an LM-2500 gas turbine, rated at a nominal 23 MW, and the Genetics Institute facility has a 5 MW Solar gas turbine.

The SCONO<sub>x</sub> system was proposed for use by PG&E Generating Company at its La Paloma facility; however, PG&E Generating no longer plans to use the SCONO<sub>x</sub> system at that site.<sup>20</sup> The SCONO<sub>x</sub> system was also proposed for demonstration by PG&E Generating Company at the Otay Mesa Generating Project; however, PG&E Generating Company sold the project to Calpine and Calpine has indicated that it no longer plans to use SCONO<sub>x</sub>. Although the technology's co-developer, Sunlaw, proposed to use the technology in conjunction with ABB gas turbines at the Nueva Azalea site in Southern California, the Nueva Azalea project has been withdrawn from the CEC licensing process.

The University of California, San Diego, operates two SoLoNox Titan 130S combustion turbines that are equipped with SCONO<sub>x</sub>. Each CTG is rated at approximately 13 MW and has NO<sub>x</sub> and CO emissions limits of 2.5 and 5.0 ppmvd @ 15% O<sub>2</sub>, 3-hour average, respectively. Quarterly emission reports for the first 3 quarters of 2002 showed that Unit 1 had 5219 hours of operation with 9 3-hour periods of excess emissions, while Unit 2 had 5294 hours of operation with no exceedances of the 2.5 ppm NO<sub>x</sub> limit. In 2002, the SCONO<sub>x</sub> catalyst had to be washed three times, with the units taken off-line each time.

Redding Electric Utility operates a 43 MW Alstom Power Model GTX 100 CTG that is equipped with SCONO<sub>x</sub> at its Redding power plant. The unit has NO<sub>x</sub> and CO limits of 2.5 and 6.0 ppmvd @ 15% O<sub>2</sub>, one-hour average basis, respectively, with a "demonstration" NO<sub>x</sub> limit of 2.0 ppm. Despite initial compliance problems, the turbine is currently operating in compliance with the 2.5 ppm NO<sub>x</sub> limit, but the operator is having to wash the catalyst more often than expected. The unit has not been able to consistently meet the 2.0 ppm "demonstration" limit.

As discussed further below, there are serious questions about the probability of a successful commercial demonstration and the commercial availability of the technology for application to the SFERP, as well as the levels of emission control that can be consistently achieved. However, based on the preceding discussion, the SCONO<sub>x</sub> system will be considered as technologically feasible for the purposes of this analysis.

Based on the discussions above, the following NO<sub>x</sub> control technologies are available and potentially technologically feasible for the proposed project:

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<sup>15</sup> ABB Environmental, op cit

<sup>16</sup> Ibid

<sup>17</sup> ABB TMP, op cit

<sup>18</sup> Letter from ABB Alstom Power to Sunlaw Energy Corporation dated February 11, 2000. (ABB Sunlaw)

<sup>19</sup> ABB Environmental, op cit

<sup>20</sup> Ibid

- Water injection
- Selective Catalytic Reduction
- SCONOx

### 8.1E.1.3 Rank Remaining Control Technologies by Control Effectiveness

The remaining technically feasible control technologies are ranked by NOx control effectiveness in Table 8.1-E-1.

**TABLE 8.1E-1**  
NOx Control Alternatives

NOx Control Alternative	Available?	Technically Feasible?	NOx Emissions (@ 15% O <sub>2</sub> )	Environmental Impact	Energy Impacts
Water Injection	Yes	Yes	25 ppm	Increased CO/VOC	Decreased Efficiency
Steam Injection	No	No	15 – 25 ppm	Increased CO/VOC	Increased Efficiency
Dry Low-NOx Combustors	No	No	9-25 ppm	Reduced CO/VOC	Increased Efficiency
Selective Catalytic Reduction	Yes	Yes	>90% reduction 1 – 2.5 ppm	Ammonia slip	Decreased Efficiency
SCONOx	Yes <sup>a</sup>	Yes	>90% reduction 1 – 2.5 ppm	Reduced CO; potential reduction in VOC	Decreased Efficiency

a. There are no standard, commercial guarantees for LM6000 projects for this technology available in the public domain.

### 8.1E.1.4 Available Control Options and Technical Feasibility

In a March 24, 2000 letter sent to local air pollution control districts, EPA Region 9 stated that the SCONOx Catalytic Adsorption System should be included in any BACT/LAER analysis for combined cycle combustion turbine power plant projects since it can achieve the BACT/LAER emission specification for NOx of 2.5 ppmvd @ 15% O<sub>2</sub>, averaged over one hour or 2.0 ppmvd @ 15% O<sub>2</sub>, averaged over three hours. In this letter, EPA stated that ABB Alstom Power, the exclusive licensee for SCONOx applications, has conducted “full-scale damper testing” that demonstrates that SCONOx is technically feasible for utility-scale combustion turbines. Stone & Webster Management Consultants, Inc. of Denver, Colorado was subsequently hired by ABB to conduct an independent technical review of the SCONOx technology as well as the full-scale damper testing program. According to the report by Stone & Webster, modifications to the actuators, fiberglass seals, and louver shaft-seal interface are being incorporated to resolve unacceptable reliability and leakage problems. However, no subsequent testing of the redesigned components has occurred to determine if the problems have been solved. Because the feasibility of the “scale-up” of the SCONOx system for large turbines has not been

demonstrated, SCONOx is not considered to be a demonstrated NO<sub>x</sub> control technology for projects of the size of the SFERP. Further, the SFERP consists of simple-cycle and not combined-cycle combustion turbines.

Although SCONOx is not considered to be a demonstrated control alternative for this project, it may be considered a technically feasible technology, and thus we have analyzed the collateral impacts of both SCR and SCONOx. Because SCONOx does not offer any emission control benefits over SCR control technology, the following analysis compares the cost-effectiveness and collateral impacts of the two technologies. The analysis shown in Table 8.1E-2 applies to three GE LM6000 combustion turbines equipped with water injection and an uncontrolled NO<sub>x</sub> emission rate of 25 ppmvd @ 15% O<sub>2</sub>.

**TABLE 8.1E-2**  
Top-Down BACT Analysis Summary for NO<sub>x</sub>

Control Technology	Controlled Emissions, tpy <sup>a</sup>	Emissions Controlled, tpy <sup>b</sup>	Average Cost-Effectiveness, \$/ton <sup>c</sup>	Electricity Cost Impact, \$/kwh <sup>d</sup>	Collateral Toxic Impacts?	Incremental Energy Impact, MMBtu/yr <sup>e</sup>
SCONOx	39.8	224.7	\$18,671	0.981	No	109,818
SCR	39.8	224.7	\$7,253	0.381	No	61,119

a. From Table 8.1A-5, based on 2.5 ppmvd controlled emission rate. Total, three turbines.

b. Based on 25 ppmvd uncontrolled emission rate from turbines, 90% control. Total, three turbines.

c. Total annual costs from ONSITE SYCOM Energy Corporation report for US DOE: "Cost Analysis of NO<sub>x</sub> Control Alternatives for Stationary Gas Turbines, Contract No. DE-FC02-97CHIO877," October 15, 1999. Scaled for 47.5 MW LM6000 turbine from data in Tables A-5 and A-7.

d. Electricity cost from Ref c.

e. "Towantic Energy Project Revised BACT Analysis", RW Beck, February 18, 2000; based upon increased fuel use required to overcome catalyst bed back pressure. Scaled by ratio of Frame 7FA unit to LM6000 unit, or 161 MW/47.5 MW.

## Energy Impacts

As shown in Table 8.1E-2, the use of SCR does not result in any significant or unusual energy penalties or benefits when compared to SCONOx. Although the operation and maintenance of SCONOx does result in a greater energy penalty when compared to that of SCR, this is not considered significant enough to eliminate SCONOx as a control alternative.

## Economic Impacts

According to EPA's 1990 Draft New Source Review Workshop Manual, "Average and incremental cost effectiveness are the two economic criteria that are considered in the BACT analysis."

As shown in Table 8.1E-2, the average cost-effectiveness of both SCR and SCONOx meet the current District cost-effectiveness guideline of \$17,500 per ton of NO<sub>x</sub> abated. However, the average cost-effectiveness of SCR is approximately 40% of the average cost-effectiveness of SCONOx. These figures are based on total annualized cost figures

from a cost analysis conducted by ONSITE SYCOM Energy Corporation.<sup>21</sup> Although SCONOx will result in greater economic impact as quantified by average cost effectiveness, this impact is not considered adverse enough to eliminate SCONOx as a control alternative. Incremental cost-effectiveness does not apply since SCR and SCONOx both achieve the BACT standard for NOx of 2.5 ppmvd @ 15% O<sub>2</sub>, averaged over three hours and therefore achieve the same NOx emission reduction in tons per year.

## Environmental Impacts

The use of SCR will result in ammonia emissions due to an allowable ammonia slip limit of 10 ppmvd @ 15% O<sub>2</sub>. A health risk screening analysis of the proposed project using air dispersion modeling showed an acute hazard index and a chronic hazard index to be each much less than 1, resulting from an ammonia slip limit of 10 ppmv @ 15% O<sub>2</sub>. In accordance with the District Toxic Risk Management Policy and currently accepted practice, a hazard index of less than 1.0 or above is considered not significant. Therefore, the toxic impact of the ammonia slip resulting from the use of SCR is deemed to be not significant and is not a sufficient reason to eliminate SCR as a control alternative.

The ammonia emissions resulting from the use of SCR may have another environmental impact through its potential to form secondary particulate matter such as ammonium nitrate. Because of the complex nature of the chemical reactions and dynamics involved in the formation of secondary particulates, it is difficult to estimate the amount of secondary particulate matter that will be formed from the emission of a given amount of ammonia. However, the Research and Modeling section of the BAAQMD Planning Division has stated in previous CEC proceedings that the formation of ammonium nitrate in the Bay Area air basin is limited by the formation of nitric acid and not driven by the amount of ammonia in the atmosphere. Therefore, ammonia emissions from the proposed SCR system are not expected to contribute significantly to the formation of secondary particulate matter within the BAAQMD.

A second potential environmental impact that may result from the use of SCR involves the storage and transport of aqueous ammonia. Although ammonia is toxic if swallowed or inhaled and can irritate or burn the skin, eyes, nose, or throat, it is a commonly used material that is typically handled safely and without incident. The SFERP will be required to maintain a Risk Management Plan (RMP) and implement a Risk Management Program to prevent accidental releases (see Section 8.5 of the AFC). The RMP will provide information on the hazards of the substance handled at the facility and the programs in place to prevent and respond to accidental releases. The accident prevention and emergency response requirements reflect existing safety regulations and sound industry safety codes and standards. In addition, the modeling analyses of the health impacts arising from a catastrophic release of ammonia due to spontaneous storage tank failure at the SFERP shows that the impact would not be significant. Thus the potential environmental impact due to aqueous ammonia storage at the SFERP does not justify the elimination of SCR as a control alternative.

## Conclusion

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<sup>21</sup> ONSITE SYCOM Energy Corporation for US DOE: "Cost Analysis of NOx Control Alternatives for Stationary Gas Turbines," Contract No. DE-FC02-97CHIO877, October 15, 1999.

Because both SCR and SCONOx can achieve the proposed BACT NO<sub>x</sub> emission limit of 2.5 ppmvd @ 15% O<sub>2</sub> averaged over three hours and neither will cause significant energy, economic, or environmental impacts, neither can be eliminated as viable control alternatives. The concern remains regarding the long-term effectiveness of SCONOx as a control technology as the technology has not been demonstrated on the turbines used in this project. For this reason, and because SCR is already in use at the facility, SCR has been selected as the NO<sub>x</sub> control technology to be used for the the SFERP.

### **8.1E.2 Determination of BACT Emission Rates**

The BACT analysis performed for NO<sub>x</sub> control includes the following:

- Review of published BACT guidelines for natural gas-fired simple cycle gas turbines;
- Review of recent BACT decisions for natural gas-fired simple-cycle gas turbines;
- Review of continuous NO<sub>x</sub> emissions monitoring data for natural gas-fired simple-cycle gas turbines obtained from EPA's acid rain website;
- Review of federal NSPS for natural gas-fired simple cycle gas turbines; and
- Review of published prohibitory rules for natural gas-fired simple cycle gas turbines.

#### **Published BACT Guidelines**

Published BACT determinations from the following agencies were reviewed to identify relevant previously established BACT guidelines:

- California Air Resources Board (ARB);
- Bay Area Air Quality Management District (BAAQMD);
- San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD); and
- South Coast Air Quality Management District (SCAQMD).

ARB's BACT Clearinghouse contained determinations by the Sacramento Metropolitan Air Quality Management District (SMAQMD) that specified water injection and SCR achieving an emission limit of 5 ppmv @ 15% O<sub>2</sub> as BACT for the following facilities:

- Carson Energy Group cogeneration plant in Sacramento, California; and
- Sacramento Cogeneration Authority cogeneration plant in Sacramento, California.

This clearinghouse has not been updated since 2000. ARB is also in the process of developing a new guideline document for power plant permitting. The most recent available ARB document on this

subject<sup>22</sup> indicated that BACT for NO<sub>x</sub> from gas turbines without heat recovery systems rated at < 50 MW was still 5 ppmv @ 15% O<sub>2</sub> on a 3-hour average basis.

The BAAQMD's BACT guidelines specify that, for natural gas-fired simple cycle combustion gas turbines, a NO<sub>x</sub> limit of 5 ppmv @ 15% O<sub>2</sub> has been "achieved in practice." This BACT guideline was established in CARB's Guidance for Power Plant Siting and Best Available Control Technology (June 1999).

The SJVUAPCD's BACT guidelines contained a determination for gas turbines rated at less than 50 MW with uniform load and without heat recovery. The SJVUAPCD concluded that a NO<sub>x</sub> exhaust concentration of 5 ppmv @ 15% O<sub>2</sub> constituted BACT that had been achieved in practice and 3 ppmv @ 15% O<sub>2</sub> constituted BACT that is technologically feasible.

### **Recent BACT Decisions**

The ARB staff has prepared a draft table summarizing NO<sub>x</sub> emission control requirements and permitted emission levels for simple-cycle power plant gas turbines. This table showed that most of the recently-permitted simple-cycle gas turbine projects in California have been required to meet NO<sub>x</sub> BACT limits of 2.5 to 3 ppmvd @ 15% O<sub>2</sub> on a 3-hour average basis. The most recent of these BACT determinations was made by the SJVUAPCD for the Modesto Irrigation District MEGS project, which also consists of GE LM6000 Sprint gas turbines equipped with water injection and SCR for NO<sub>x</sub> control. For this project, which has been approved by the District and was licensed by the CEC on February 4, 2004, NO<sub>x</sub> BACT was determined to be 2.5 ppmvd @ 15% O<sub>2</sub> on a 3-hour average basis.

This table also shows that in 2001, the Massachusetts Department of Environmental Protection issued two permits for GE LM6000 simple-cycle gas turbines with NO<sub>x</sub> emissions limitations of 2.0 ppmvd @ 15% O<sub>2</sub> on a 1-hour average basis. Only one of these facilities is currently in operation and reporting emissions data to EPA, and as discussed below, the operating facility has not been able to meet this limit in operation. The NO<sub>x</sub> limit has been changed to 3.5 ppmvd @ 15% O<sub>2</sub>, which is higher than the level considered to be BACT in California.

The SCAQMD database included a December 2001 determination for the Wildflower Energy Indigo power plant that BACT for NO<sub>x</sub> for a simple-cycle LM5000 Sprint gas turbine was 5 ppm on a 1-hour average basis.

### **Review of NO<sub>x</sub> CEMS Data**

Real-time hourly NO<sub>x</sub> CEMS data are available on EPA's Acid Rain website for generating units that are subject to acid rain reporting requirements. The reported NO<sub>x</sub> data for the West Springfield Redevelopment Project simple-cycle gas turbines were analyzed for compliance with the original permit limit of 2.0 ppmvd @ 15% O<sub>2</sub>, 1-hour average basis. Five quarters of monitoring data were available for each of the two West Springfield Redevelopment Project units. Analysis of these data showed that when low-load, startup/shutdown and commissioning periods were excluded, the turbines operated in compliance with the 2.0 ppm, 1-hour average permit limit only between 10

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<sup>22</sup> ARB Guidance for the Permitting of Electrical Generation Technologies, July 2002.

and 20% of the time (see Table 8.1E-3). Even a 3.0 ppm, 3-hour average limit would have been exceeded almost 10% of the time. The NOx limit for these turbines was recently revised to 3.5 ppmvd @ 15% O<sub>2</sub>.

### Federal NSPS

The NSPS applicable to new natural gas-fired combustion gas turbines are found in Title 40 CFR Part 60 Subpart GG. As discussed in Section 8.1.4.2.2 of the application, the NOx emission limit applicable to the proposed combustion gas turbines will be 109 ppmv @ 15% O<sub>2</sub>.

**Table 8.1E-3**

Summary of NOx Emissions Performance: West Springfield Redevelopment Project LM6000 Simple Cycle Gas Turbines

Unit/Period	Averaging Prd	Exceedance Frequency Based on NOx Limit, ppmvd @ 15% O <sub>2</sub>		
		3.0	2.5	2.0
Unit 1				
5/1 to 12/31/2002	1 hour	14%	43%	84%
	3 hours	11%	37%	82%
1/1 to 6/30/2003	1 hour	20%	34%	98%
	3 hours	13%	27%	99%
Unit 2				
5/1 to 12/31/2002	1 hour	11%	53%	79%
	3 hours	9%	56%	77%
1/1 to 6/30/2003	1 hour	7%	16%	90%
	3 hours	5%	18%	91%

### District Prohibitory Rules

Published prohibitory rules from the BAAQMD, SMAQMD, San Diego County Air Pollution Control District (SDCAPCD), SJVUAPCD, and SCAQMD were reviewed to identify the NOx standards that govern existing natural gas-fired simple cycle combustion gas turbines.

- BAAQMD adopted Rule 9-9 (Nitrogen Oxides from Stationary Gas Turbines) to limit NOx emissions from these devices. Rule 9-9 specifies an efficiency-adjusted NOx emission limit of 13.0 ppmv @ 15% O<sub>2</sub> for natural gas-fired combustion gas turbines rated at no less than 10 MW, rated at 9,353 Btu/kW-hr (HHV), and equipped with SCR.
- The SMAQMD adopted Rule 413 (Stationary Gas Turbines) to limit NOx emissions from these devices. Rule 413 specifies a NOx emission limit of 9 ppmv @ 15% O<sub>2</sub> for natural gas-fired combustion gas turbines rated at no less than 10 MW and equipped with SCR.

- The SJVUAPCD adopted Rule 4703 (Stationary Gas Turbines) to limit NO<sub>x</sub> emissions from these devices. Rule 4703 specifies an enhanced Tier II NO<sub>x</sub> emission limit of 3 ppmv @ 15% O<sub>2</sub> for natural gas-fired combustion gas turbines rated at no less than 10 MW and equipped with SCR (April 30, 2008 deadline).
- The SCAQMD adopted Rule 1134 (Emissions of Oxides of Nitrogen from Stationary Gas Turbines) to limit NO<sub>x</sub> emissions from these devices. Rule 1134 specifies an efficiency-adjusted NO<sub>x</sub> emission limit of 13 ppmv @ 15% O<sub>2</sub> for natural gas-fired combustion gas turbines rated no less than 10 MW, rated at 9,353 Btu/kW-hr, and equipped with SCR.

## **Conclusions**

BACT must be at least as stringent as the most stringent level achieved in practice, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the NO<sub>x</sub> BACT determination of 2.5 ppm @ 15% O<sub>2</sub> on a 3-hour average basis made for recently permitted simple cycle turbine projects in the Bay Area and the SJVUAPCD reflects the most stringent achievable NO<sub>x</sub> emission limit. Therefore, BACT for NO<sub>x</sub> emissions for natural gas-fired simple cycle combustion gas turbines is 2.5 ppmv @ 15% O<sub>2</sub>. The SFERP facility will be designed to meet a NO<sub>x</sub> level of 2.5 ppmv @ 15% O<sub>2</sub> on a 3-hour average basis.

## **Carbon Monoxide**

The BACT analysis performed for CO control includes the following:

- Review of published BACT guidelines for natural gas-fired simple cycle combustion gas turbines;
- Review of recent BACT decisions for natural gas-fired simple-cycle gas turbines;
- Review of federal NSPS for natural gas-fired simple cycle combustion gas turbines; and
- Review of published prohibitory rules for natural gas-fired simple cycle combustion gas turbines.

## **Published BACT Guidelines**

As discussed in the previous section, published BACT determinations from the following agencies were reviewed to identify any previously established BACT guidelines:

- ARB;
- BAAQMD;
- SJVUAPCD; and
- SCAQMD.

The ARB's BACT guidance document for electric generating units rated at less than 50 MW<sup>23</sup> indicates that BACT for the control of CO emissions from stationary gas turbines rated at less than 50 MW used in electrical generation is 6 ppmvd @ 15% O<sub>2</sub>.

The BAAQMD's BACT guidelines specify that, for natural gas-fired simple cycle combustion gas turbines, a CO limit of 6 ppmv @ 15% O<sub>2</sub> has been "achieved in practice." A BACT guideline of 6 ppmv @ 15% O<sub>2</sub> was established in CARB's Guidance for Power Plant Siting and Best Available Control Technology (June 1999).

The SJVUAPCD's BACT guidelines contained a determination for gas turbines rated at less than 50 MW with uniform load and without heat recovery. The SJVUAPCD concluded that a CO exhaust concentration of 6 ppmv @ 15% O<sub>2</sub> constituted BACT that had been achieved in practice.

The SCAQMD database did not contain BACT guidelines for VOC emissions from natural gas-fired simple cycle combustion gas turbines.

### **Recent BACT Decisions**

The ARB staff has prepared a draft table of NO<sub>x</sub> emission control requirements and permitted emission levels for simple-cycle power plant gas turbines. This table, which includes information regarding limits for VOC, CO, PM<sub>10</sub>, SO<sub>2</sub> and ammonia, shows that most of the recently-permitted simple-cycle gas turbine projects in California have been required to meet CO BACT limits of 6 ppmvd @ 15% O<sub>2</sub> on a 1-hour average basis. The most recent of these BACT determinations was made by the SJVUAPCD for the Modesto Irrigation District Ripon project, which also consists of GE LM6000 Sprint gas turbines equipped with water injection and SCR for NO<sub>x</sub> control. For this project, which has been approved by the District and is expected to be licensed by the CEC before the end of 2003, CO BACT was determined to be 6 ppmvd @ 15% O<sub>2</sub> on a 3-hour average basis.

The SCAQMD database included a December 2001 determination for the Wildflower Energy Indigo power plant that BACT for CO for a simple-cycle LM5000 Sprint gas turbine was 6 ppm on a 1-hour average basis.

### **Federal NSPS**

The NSPS applicable to new natural gas-fired combustion gas turbines are found in Title 40 CFR Part 60 Subpart GG. This NSPS does not specify an emission limit for CO.

### **District Prohibitory Rules**

Published prohibitory rules from the BAAQMD, SMAQMD, SDCAPCD, SJVUAPCD, and SCAQMD were reviewed to identify the CO standards that govern existing natural gas-fired simple cycle combustion gas turbines. Of the five prohibitory rules reviewed, the SJVUAPCD prohibitory rule for combustion gas turbines is the only one that includes an emission limit for CO (200 ppmv @ 15% O<sub>2</sub>). Generic prohibitory rules (i.e., not device specific) from each of these districts were also reviewed; emission limits are 2000 ppmv at actual operating conditions.

### **Conclusions**

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<sup>23</sup> Ibid, Table I-1.

BACT must be at least as stringent as the most stringent level required in a permit, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the BAAQMD BACT determination for natural gas-fired simple cycle combustion gas turbines, obtained from CARB's Guidance for Power Plant Siting and Best Available Control Technology, reflects the most stringent CO emission limit. Therefore, BACT for CO emissions from natural gas-fired simple cycle combustion gas turbines is 6 ppmv @ 15% O<sub>2</sub>. The proposed CO emission limit of 4 ppmvd @ 15% O<sub>2</sub> on a 3-hour average basis is more stringent than the level currently considered BACT, but is expected to be achievable in practice.

## **Volatile Organic Compounds**

The BACT analysis performed for VOC control includes the following:

- Review of published BACT guidelines for natural gas-fired simple cycle combustion gas turbines;
- Review of recent BACT decisions for natural gas-fired simple-cycle gas turbines;
- Review of federal NSPS for natural gas-fired simple cycle combustion gas turbines; and
- Review of published prohibitory rules for natural gas-fired simple cycle combustion gas turbines.

## **Published BACT Guidelines**

As discussed previously, published BACT determinations from the following agencies were reviewed to identify any previously established BACT guidelines:

- ARB;
- BAAQMD;
- SJVUAPCD; and
- SCAQMD.

The ARB's BACT guidance document for electric generating units rated at less than 50 MW<sup>24</sup> indicates that BACT for the control of POC emissions from stationary gas turbines rated at less than 50 MW used in electrical generation is 2 ppmvd @ 15% O<sub>2</sub>.

ARB's BACT Clearinghouse contained SMAQMD determinations that specified an oxidation catalyst achieving an emission limit of 2.1 ppmv @ 15% O<sub>2</sub> as BACT for the following facilities:

- Carson Energy Group cogeneration plant in Sacramento, California; and
- Sacramento Cogeneration Authority cogeneration plant in Sacramento, California.

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<sup>24</sup> Ibid, Table I-1.

The BAAQMD's BACT guidelines specify that, for natural gas-fired simple cycle combustion gas turbines, a VOC limit of 2 ppmv @ 15% O<sub>2</sub> has been "achieved in practice." This BACT guideline was established in CARB's Guidance for Power Plant Siting and Best Available Control Technology (June 1999).

The SJVUAPCD's BACT guidelines contained a determination for gas turbines rated at less than 50 MW with uniform load and without heat recovery. The SJVUAPCD concluded that a VOC exhaust concentration of 2.0 ppmv @ 15% O<sub>2</sub> constituted BACT that had been achieved in practice.

The SCAQMD database did not contain BACT guidelines for VOC emissions from natural gas-fired simple cycle combustion gas turbines.

### **Recent BACT Decisions**

The ARB staff has prepared a draft table summarizing NO<sub>x</sub> emission control requirements and permitted emission levels for simple-cycle power plant gas turbines. This table, which includes information regarding limits for VOC, CO, PM<sub>10</sub>, SO<sub>2</sub> and ammonia, shows that most of the recently-permitted simple-cycle gas turbine projects in California have been required to meet VOC BACT limits of 2 ppmvd @ 15% O<sub>2</sub> on a 1- or a 3-hour average basis. The most recent of these BACT determinations was made by the SJVUAPCD for the Modesto Irrigation District Ripon project, which also consists of GE LM6000 Sprint gas turbines equipped with water injection and SCR for NO<sub>x</sub> control. For this project, which has been approved by the District and is expected to be licensed by the CEC before the end of 2003, VOC BACT was determined to be 2 ppmvd @ 15% O<sub>2</sub> on a 3-hour average basis.

The SCAQMD database included a December 2001 determination for the Wildflower Energy Indigo power plant that BACT for VOC for a simple-cycle LM5000 Sprint gas turbine was 2 ppm on a 1-hour average basis.

### **Federal NSPS**

The NSPS applicable to new natural gas-fired combustion gas turbines are found in Title 40 CFR Part 60 Subpart GG. This NSPS does not specify an emission limit for VOC.

### **District Prohibitory Rules**

Published prohibitory rules from the BAAQMD, SMAQMD, SDCAPCD, SJVUAPCD, and SCAQMD were reviewed to identify the VOC standards that govern existing natural gas-fired simple cycle combustion gas turbines. None of the prohibitory rules for combustion gas turbines, discussed previously in Section IV.A.3, specify an emission limit for VOC. Generic prohibitory rules (i.e., not device specific) from each of these districts were also reviewed; none contain an emission limit for VOC.

### **Conclusions**

BACT must be at least as stringent as the most stringent BACT determination, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the BAAQMD BACT determination for natural gas-fired simple cycle combustion gas turbines, obtained from CARB's Guidance for Power Plant Siting and Best Available Control Technology, reflects the most stringent VOC emission limit. The BAAQMD established VOC emission limits of 2 ppmv @ 15% O<sub>2</sub> for natural gas-fired simple cycle combustion gas turbines. Therefore, BACT for VOC emissions from natural gas-fired simple cycle combustion gas turbines is 2 ppmv @ 15% O<sub>2</sub>.

### **Particulate Matter Less Than 10 Microns in Diameter (PM<sub>10</sub>)**

The BACT analysis performed for PM<sub>10</sub> includes the following:

- Review of published BACT guidelines for comparable natural gas-fired simple cycle combustion turbines;
- Review of recent BACT decisions for natural gas-fired simple-cycle gas turbines;
- Review of federal NSPS for small natural gas-fired simple cycle combustion gas turbines; and
- Review of published prohibitory rules for comparable natural gas-fired simple cycle combustion gas turbines.

### **Published BACT Guidelines**

Published BACT determinations from the following agencies were reviewed to identify any previously established BACT guidelines:

- ARB;
- BAAQMD;

- SJVUAPCD; and
- SCAQMD.

The ARB BACT Clearinghouse, as well as the BAAQMD and SJVUAPCD BACT guidelines, identify the use of natural gas as the primary fuel as “achieved in practice” for the control of PM<sub>10</sub> for small simple cycle combustion gas turbines.

The ARB’s BACT guidance document for electric generating units rated at less than 50 MW<sup>25</sup> indicates that BACT for the control of PM emissions from stationary gas turbines rated at less than 50 MW used in electrical generation is an emission limit corresponding to natural gas with fuel sulfur content of no more than 1 grain/100 standard cubic foot.

The SCAQMD database contained BACT determinations for the Los Angeles Department of Power and Water plant in Sun Valley, CA, and the Indigo Energy Facility in North Palm Springs, CA. The SCAQMD concluded that an exhaust PM<sub>10</sub> concentration of 0.01 gr/dscf (equivalent to 11 lb/hr) constituted BACT.

#### **Recent BACT Decisions**

The ARB staff has prepared a draft table summarizing NOx emission control requirements and permitted emission levels for simple-cycle power plant gas turbines. This table, which includes information regarding limits for VOC, CO, PM<sub>10</sub>, SO<sub>2</sub> and ammonia, shows that most of the recently-permitted simple-cycle gas turbine projects in California have been required to meet PM<sub>10</sub> limits of 3.0 lb/hr.

#### **Federal NSPS**

Title 40 CFR Part 60 Subpart GG contains the applicable NSPS for combustion gas turbines. Section III.H previously identified the requirements of Subpart GG applicable to the proposed combustion gas turbine; Subpart GG does not regulate PM<sub>10</sub> emissions.

#### **District Prohibitory Rules**

Published prohibitory rules from the District, SCAQMD, SJVUAPCD, SMAQMD, and SDCAPCD were reviewed to identify the PM<sub>10</sub> standards that govern existing small natural gas-fired combustion gas turbines:

- BAAQMD adopted Rule 9-9 (Nitrogen Oxides from Stationary Gas Turbines) to limit NOx emissions from these devices. Rule 9-9 does not regulate PM<sub>10</sub> emissions.
- BAAQMD Regulation 6 (Particulate Matter and Visible Emissions) specifies a PM emission limit of 0.15 gr/dscf for sources of PM emissions.
- The SMAQMD adopted Rule 413 (Stationary Gas Turbines) to limit NOx emissions from these devices. Rule 413 does not regulate PM<sub>10</sub> emissions.
- SMAQMD Rule 404 (Particulate Matter) specifies a PM emission limit of 0.1 gr/dscf for sources of PM emissions.

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<sup>25</sup> Ibid, Table I-1.

- SMAQMD Rule 406 (Specific Contaminants) specifies a PM emission limit of 0.1 gr/dscf @ 12% CO<sub>2</sub> for combustion sources.
- The SDCAPCD adopted Rule 69.3.1 (Stationary Gas Turbine Engines – Best Available Retrofit Control Technology) to limit NO<sub>x</sub> emissions from these devices. Rule 69.3.1 does not regulate PM<sub>10</sub> emissions.
- SDCAPCD Rule 52 (Particulate Matter) specifies a PM<sub>10</sub> emission limit of 0.1 gr/dscf for sources of PM emissions.
- SDCAPCD Rule 53 (Specific Air Contaminants) specifies a PM emission limit of 0.1 gr/dscf @ 12% CO<sub>2</sub> for combustion sources.
- The SJVUAPCD adopted Rule 4703 (Stationary Gas Turbines) to limit NO<sub>x</sub> emissions from these devices. Rule 4703 does not regulate PM<sub>10</sub> emissions.
- SJVUAPCD Rule 4201 (Particulate Matter - Concentration) specifies a PM emission limit of 0.1 gr/dscf for sources of PM emissions.
- SJVUAPCD Rule 4301 (Fuel Burning Equipment) specifies a PM emission limit of 0.1 gr/dscf @ 12% CO<sub>2</sub> for combustion sources.
- The SCAQMD adopted Rule 1134 (Emissions of Oxides of Nitrogen from Stationary Gas Turbines) to limit NO<sub>x</sub> emissions from these devices. Rule 1134 does not regulate PM<sub>10</sub> emissions.
- SCAQMD Rule 404 (Particulate Matter - Concentration) specifies a PM emission limit of 0.0437 gr/dscf for sources of PM emissions.
- SCAQMD Rule 409 (Combustion Contaminants) specifies a PM emission limit of 0.1 gr/dscf @ 12% CO<sub>2</sub> for combustion sources.

## Conclusions

BACT must be at least as stringent as the most stringent BACT determination, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the BAAQMD BACT guideline reflects the most stringent PM<sub>10</sub> emission limit. The District established a requirement for the use of natural gas as the primary fuel to control PM<sub>10</sub> emissions from combustion gas turbines. Therefore, the use of natural gas as the primary fuel source constitutes BACT for PM<sub>10</sub> emissions from small simple cycle combustion gas turbines. Through the use of natural gas, the turbines are expected to be able to meet the proposed emission limit of 3.0 lb/hr per turbine.

## Sulfur Oxides

The BACT analysis performed for SO<sub>x</sub> included the following:

- Review of published BACT guidelines for small natural gas-fired simple cycle combustion turbines;
- Review of recent BACT decisions for natural gas-fired simple-cycle gas turbines;
- Review of federal NSPS for small natural gas-fired simple cycle combustion gas

turbines; and

- Review of published prohibitory rules for small natural gas-fired simple cycle combustion gas turbines.

### **Published BACT Guidelines**

Published BACT determinations from the following agencies were reviewed to identify any previously established BACT guidelines:

- ARB;
- BAAQMD;
- SJVUAPCD; and
- SCAQMD.

The CARB BACT Clearinghouse, as well as the BAAQMD and SJVUAPCD BACT guidelines, identify the use of PUC-quality natural gas or natural gas with a limit on the sulfur content (i.e., 1 grain/100 scf) as the primary fuel as “achieved in practice” for the control of SO<sub>x</sub> for small simple cycle combustion gas turbines. The two most recent BACT determinations in the SCAQMD did not indicate BACT for SO<sub>x</sub>.

### **Recent BACT Decisions**

The ARB staff has prepared a draft table of NO<sub>x</sub> emission controls required for simple-cycle power plant gas turbines. This table, which includes information regarding limits for VOC, CO, PM<sub>10</sub>, SO<sub>2</sub> and ammonia) showed that most of the recently-permitted simple-cycle gas turbine projects in California have been required to meet hourly SO<sub>2</sub> limits that correspond to fuel sulfur content limits of between 0.33 and 1.0 gr/100 scf.

### **Federal NSPS**

Title 40 CFR Part 60 Subpart GG contains the applicable NSPS for combustion gas turbines. Section III.B previously identified the requirements of Subpart GG applicable to the proposed combustion gas turbine. A combustion gas turbine is subject to a SO<sub>2</sub> emission limit of 0.015% by volume (150 ppmv) @ 15% O<sub>2</sub>. The NSPS also limits the sulfur content of fuel to 0.8% by weight.

### **District Prohibitory Rules**

Published prohibitory rules from the BAAQMD, SJVUAPCD, and SCAQMD were reviewed to identify the SO<sub>2</sub> standards that govern existing gas turbines.

- BAAQMD Rule 9-9 (Nitrogen Oxides from Stationary Gas Turbines) is the BAAQMD’s only prohibitory rule that specifically addresses gas turbines but does not limit SO<sub>2</sub> emissions. The BAAQMD adopted Rule 9-1 (Sulfur Dioxide) to limit SO<sub>2</sub> emissions from all sources. Rule 9-1 prohibits SO<sub>2</sub> emissions in excess of 300 ppm. No other BAAQMD Rule or Regulation contains a relevant prohibitory rule regulating either the sulfur content in the fuel or the emission of SO<sub>2</sub> from gas turbines.
- SJVUAPCD Rule 4703 (Stationary Gas Turbines) is the SJVUAPCD’s only

prohibitory rule that specifically addresses gas turbines but does not limit SO<sub>2</sub> emissions. The SJVUAPCD adopted Rule 4301 (Fuel Burning Equipment) to limit SO<sub>2</sub> emissions from these devices. Rule 4301 specifies a SO<sub>2</sub> emission limit of 200 pounds per hour. The SJVUAPCD also adopted Rule 4801 (Sulfur Compounds) to limit emissions of sulfur compounds. Rule 4801 specifies a SO<sub>2</sub> emission limit of 0.2%, or 2,000 ppm.

- SCAQMD Rule 1134 (Emissions of Oxides of Nitrogen from Stationary Gas Turbines) is the SCAQMD's only prohibitory rule that specifically addresses gas turbines but does not limit SO<sub>2</sub> emissions. The SCAQMD adopted Rule 431.1 (Sulfur Content of Gaseous Fuels) to reduce SO<sub>x</sub> emissions from the burning of gaseous fuels in stationary equipment. Rule 431.1 specifies a sulfur limit of 16 grains/100 scf (as H<sub>2</sub>S) in natural gas sold within the SCAQMD. The SCAQMD also adopted Rule 407 (Liquid and Gaseous Air Contaminants) to limit SO<sub>2</sub> emissions from all sources. Rule 407 specifies an emission limit of 2,000 ppm for sulfur compounds (calculated as SO<sub>2</sub>).

## Conclusions

BACT must be at least as stringent as the most stringent BACT determination, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the CARB database and BAAQMD and SJVUAPCD BACT guidelines reflect the most stringent SO<sub>x</sub> emission limit. These sources established a requirement for the use of natural gas as the primary fuel to control SO<sub>x</sub> emissions from combustion gas turbines. Therefore, the use of natural gas as the primary fuel source constitutes BACT for SO<sub>x</sub> emissions from small simple cycle combustion gas turbines.

## Summary

The criteria that constitute BACT for the proposed natural gas-fired simple cycle combustion gas turbine are summarized in Table 8.1E-4 and compared against the design criteria for the proposed combustion gas turbine.

**Table 8.1E-4**  
Summary of Emission Limits and BACT Requirements

Pollutant	BACT	Proposed Control Level
NO <sub>x</sub>	Emission Limit = 2.5 ppmv @ 15% O <sub>2</sub>	Design Exhaust Concentration = 2.5 ppmv @ 15% O <sub>2</sub>
CO	Emission Limit = 4 ppmv @ 15% O <sub>2</sub>	Design Exhaust Concentration = 4 ppmv @ 15% O <sub>2</sub>
VOC	Emission Limit = 2 ppmv @ 15% O <sub>2</sub>	Design Exhaust Concentration = 2 ppmv @ 15% O <sub>2</sub>
SO <sub>x</sub>	Natural gas fuel	Natural gas fuel
PM <sub>10</sub>	Natural gas fuel	Natural gas fuel

APPENDIX 8.1F

## Offset Listing

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**APPENDIX 8.1F**  
**OFFSET LISTING**

**Table 8.1F-1**  
**BAAQMD Emission Bank Status - San Francisco**  
**Emission Reduction Credits Available (tons/yr)**  
**December 10, 2003**

<b>No.</b>	<b>Location</b>	<b>Certificate Owner</b>	<b>POC</b>	<b>NOX</b>	<b>Restrictions</b>
896	Potrero	Calpine Corp. & Bechtel Enterprises Hold	0.000	405.205	Limited to electric power production
740	Hunters Point	Pacific Gas and Electric Company	9.790	32.680	Limited to electric power production
767	Pacific Lithographic Co.	Midway Power, LLC	5.862	1.300	
382	1426 Donner Avenue	California Oils Corporation	0.195	0.000	
905	Louis Roesch Company	Waste Management of Alameda County	0.716	0.000	
714	Louis Roesch Company	Enron North America Corp.	1.000	0.000	
337	James H Barry Co	American Lithographers Inc.	4.230	0.000	Limited to printing industry
483	The Glidden Company	The Glidden Company	4.700	0.000	Limited to paint manufacturing
875	Colorfast Printing Co.	Cunningham Graphics a Subdiary of ADP	4.704	0.000	Limited to graphic arts industries
600	Treasure Island	U.S. Navy	0.550	3.210	
475	Treasure Island	U.S. Navy	0.300	0.130	
<b>Totals</b>			32.047	442.525	
<b>Totals, eligible for use by SFPUC</b>			18.413	442.525	

# BAAQMD Emission Bank Status

Emission Reduction Credits Available (tons/yr)

December 10, 2003

(The link in the Certificate Owner column provides contact information for the sale of ERCs.)

<b>No.</b>	<b>Certificate Owner</b>	<b>PM</b>	<b>POC</b>	<b>NOX</b>	<b>SO2</b>	<b>CO</b>	<b>NPOC</b>	<b>PM10</b>
<a href="#">11</a>	Hewlett-Packard Co; Printed Circuit Divsn						159.500	
<a href="#">17</a>	Allied Corporation				182.900			
<a href="#">18</a>	<a href="#">Rexam Beverage Can Company</a>		31.100					
<a href="#">28</a>	Carnation Company	3.700						
<a href="#">36</a>	United Airlines						1.800	
<a href="#">37</a>	Morton International Inc			0.400		0.400		
<a href="#">38</a>	<a href="#">FMC Corporation</a>						53.700	
<a href="#">39</a>	<a href="#">FMC Corporation</a>		5.800					
<a href="#">53</a>	A O Smith Corporation		10.800					
<a href="#">57</a>	Phillips 66 Company	3.600				4.900		
<a href="#">68</a>	<a href="#">FMC Corporation</a>		0.400					
<a href="#">69</a>	<a href="#">FMC Corporation</a>		1.000					
<a href="#">70</a>	Chevron Products Company		29.300					
<a href="#">96</a>	U.S. Navy		1.018					
<a href="#">112</a>	Owens Corning	1.300	14.400	0.220		0.150		0.700
<a href="#">131</a>	Phillips 66 Company - San Francisco Refinery		0.380					
<a href="#">132</a>	U.S. Navy			0.390		0.340		
<a href="#">135</a>	Gallagher & Burk; Inc							6.230
<a href="#">141</a>	Phillips 66 Company - San Francisco Refinery		0.373					
<a href="#">142</a>	Phillips 66 Company - San Francisco Refinery		0.340					
<a href="#">149</a>	Varian Oncology Systems						12.250	
<a href="#">151</a>	Lawrence Livermore National Laboratory						1.660	
<a href="#">155</a>	U.S. Navy		0.065	1.878	10.660	0.939		0.375
<a href="#">157</a>	Bay Area Air Quality Management District		1206.060	352.960				
<a href="#">160</a>	National Semiconductor Corporation		1.747					
<a href="#">168</a>	Martinez Refining Company		11.620					
<a href="#">172</a>	Chevron Products Company							0.384
<a href="#">173</a>	Varian Oncology Systems		0.235				4.469	
<a href="#">180</a>	United Technologies Corporation		0.076				4.397	
<a href="#">181</a>	Advanced Micro Devices Inc		10.880					

<a href="#">182</a>	Chevron Research and Technology Co	0.070	0.039	0.700	0.008	0.003	
<a href="#">183</a>	Chevron Research and Technology Co		0.310				
<a href="#">194</a>	RMC Lonestar	0.730					0.440
<a href="#">195</a>	RMC Lonestar	0.400					0.240
<a href="#">205</a>	U.S. Navy					6.034	
<a href="#">207</a>	Owens Corning	17.900	23.300	9.500		3.900	
<a href="#">215</a>	Monsanto Company						0.067
<a href="#">218</a>	New United Motor Manufacturing; Inc		78.830				
<a href="#">223</a>	Chevron Products Company		60.122	20.674	1.047	9.129	5.370
<a href="#">227</a>	HMT Technology Corporation		0.200				2.240
<a href="#">232</a>	American Lithographers Inc.		6.164	0.095		0.100	
<a href="#">239</a>	IBM Corporation						24.370
<a href="#">241</a>	Dexter Hysol Aerospace; Inc		4.700				
<a href="#">251</a>	Triangle Wire & Cable; Inc			0.594			
<a href="#">252</a>	General Electric Co		0.003				
<a href="#">259</a>	Burke Industries; Inc		3.026				24.850
<a href="#">262</a>	Lawrence Livermore National Laboratory						1.050
<a href="#">265</a>	Solelectron Corporation		3.710				3.350
<a href="#">266</a>	Santa Rosa Memorial Hospital			0.970			0.300
<a href="#">270</a>	Stanford University			17.300			
<a href="#">280</a>	California Cannery & Growers	0.800				6.000	
<a href="#">302</a>	Chevron Products Company		7.948				
<a href="#">310</a>	Trumbull Asphalt Company		8.900	0.400	25.900	24.200	4.200
<a href="#">325</a>	New United Motor Manufacturing; Inc		20.790				
<a href="#">328</a>	Crockett Cogeneration; A Cal Ltd Partnership		11.050	0.840		0.200	
<a href="#">329</a>	Advanced Micro Devices Inc		9.615				
<a href="#">333</a>	U.S. Navy		13.490				
<a href="#">337</a>	American Lithographers Inc.		4.230				
<a href="#">350</a>	Hewlett-Packard Company		3.290				
<a href="#">351</a>	U.S. Navy		22.786				54.600
<a href="#">360</a>	Gallagher & Burk; Inc		0.200	0.170	0.170	0.530	0.180
<a href="#">370</a>	Pacific Refining Company		1.000				
<a href="#">371</a>	Zanker Road Resource Management;Ltd		0.650	10.700	0.770		
<a href="#">372</a>	Pacific Refining Company		0.440	0.224			
<a href="#">381</a>	Laidlaw Environmental Services, Inc		1.400				1.460
<a href="#">382</a>	California Oils Corporation		0.195				
<a href="#">385</a>	Quantum Corporation						3.200

<a href="#">387</a>	Martinez Refining Company		0.096					
<a href="#">392</a>	Richard Mariani	0.600			3.300			
<a href="#">410</a>	IBM Corporation					13.980		
<a href="#">414</a>	Intel Corporation		13.920			2.140		
<a href="#">415</a>	Martinez Refining Company			15.100			8.920	
<a href="#">423</a>	Ciba Corning Diagnostics Corp		0.530					
<a href="#">424</a>	Chevron Products Company		1.608					
<a href="#">425</a>	Beckman Coulter					3.110		
<a href="#">428</a>	Martinez Refining Company		6.288					
<a href="#">434</a>	Genentech; Inc		0.384	6.646	7.798		2.660	
<a href="#">443</a>	Lawrence Livermore National Laboratory					0.121		
<a href="#">445</a>	Stanford University		3.790	14.840				
<a href="#">446</a>	Red Wing Co /California Div	0.070	0.052	0.419	0.002	0.083		0.091
<a href="#">452</a>	Soletron Corporation		2.674					
<a href="#">465</a>	Ball Metal Beverage Container Corporation			0.275				
<a href="#">475</a>	U.S. Navy		0.300	0.130		0.420		0.300
<a href="#">477</a>	U.S. Navy		7.911					
<a href="#">478</a>	Central Contra Costa Sanitary District		0.581	2.243		30.937		
<a href="#">483</a>	The Glidden Company		4.700					
<a href="#">486</a>	U.S. Navy		3.440	1.210	1.200	2.710		0.980
<a href="#">487</a>	Chevron Chemical Company	3.504		3.028				5.254
<a href="#">489</a>	Chevron Products Company			71.400				
<a href="#">491</a>	U.S. Navy		1.620	5.762	0.460	1.241	1.030	0.405
<a href="#">495</a>	Phillips 66 Company - San Francisco Refinery	0.400	0.527		2.150	42.700		
<a href="#">501</a>	U.S. Navy		0.315	8.432	0.135	9.001		0.563
<a href="#">503</a>	U.S. Navy		0.354	4.342	0.347	0.935		0.305
<a href="#">505</a>	New United Motor Manufacturing; Inc		18.470					
<a href="#">510</a>	U.S. Navy		3.490	2.430	0.210	0.580	0.220	0.590
<a href="#">514</a>	Owens Corning		6.457					
<a href="#">520</a>	New United Motor Manufacturing; Inc		112.760					
<a href="#">525</a>	Central Contra Costa Sanitary District		0.153	1.120		8.158		
<a href="#">529</a>	U.S. Navy		2.880	14.750	1.430	11.470		3.710
<a href="#">531</a>	<a href="#">Crown Cork &amp; Seal Company</a>		20.249	4.595		0.965		0.345
<a href="#">532</a>	Martinez Cogen Limited Partnership			50.200				
<a href="#">538</a>	New United Motor Manufacturing; Inc		131.900					
<a href="#">540</a>	New United Motor Manufacturing; Inc		0.218					
<a href="#">541</a>	Chevron Chemical Company		0.047				1.600	

<a href="#">543</a>	Hanson Permanente Cement					25.074
<a href="#">545</a>	U.S. Navy	2.495				
<a href="#">546</a>	Alameda Reuse & Redevelopment Authority	29.970				
<a href="#">554</a>	Lawrence Livermore National Laboratory				2.400	
<a href="#">555</a>	U.S. Navy		1.050	0.020	0.890	0.110
<a href="#">557</a>	U.S. Navy	0.650	9.090	0.140	8.160	0.700
<a href="#">559</a>	U.S. Navy	0.340	2.110			
<a href="#">560</a>	Criterion Catalysts Company LP	0.340				
<a href="#">561</a>	Pechiney Plastic Packaging; Inc	1.249				
<a href="#">563</a>	Owens Corning	1.245				
<a href="#">578</a>	Chevron Chemical Company	0.212	1.802	0.046	0.357	0.570
<a href="#">580</a>	Phillips 66 Company - San Francisco Refinery	1.290	21.230	4.190	16.140	6.450
<a href="#">581</a>	Phillips 66 Company - San Francisco Refinery	3.170	6.880	0.010	5.780	0.200
<a href="#">583</a>	WinCup Holdings;L P	0.426				
<a href="#">588</a>	Chevron Chemical Company		31.771		2.069	
<a href="#">598</a>	USS-POSCO Industries			0.140	0.790	0.700
<a href="#">600</a>	U.S. Navy	0.550	3.210	0.060	8.430	0.760
<a href="#">602</a>	Calpine Corporation	0.200	40.970	2.143	0.357	
<a href="#">603</a>	Port of Oakland		2.450			
<a href="#">609</a>	Martinez Refining Company			50.610		
<a href="#">613</a>	Martinez Refining Company		89.783			
<a href="#">617</a>	Chevron Products Company	68.898	8.790	0.473	7.449	1.514
<a href="#">619</a>	Raisch Products				0.840	
<a href="#">640</a>	New United Motor Manufacturing; Inc	27.940				13.630
<a href="#">643</a>	Homestake Mining Company	87.530			86.970	
<a href="#">645</a>	Calpine Corporation		107.900			
<a href="#">648</a>	Emerald Packaging Inc				40.000	
<a href="#">656</a>	Duke Energy Oakland LLC	324.810				
<a href="#">658</a>	Calpine Corporation	10.000	32.900		14.380	
<a href="#">661</a>	Calpine Corporation	31.750				
<a href="#">662</a>	Calpine Corporation		73.620	46.300		
<a href="#">665</a>	Calpine Corp. & Bechtel Enterprises Hold	22.778				
<a href="#">666</a>	Calpine Corp. & Bechtel Enterprises Hold	15.518				
<a href="#">674</a>	Calpine Corp. & Bechtel Enterprises Hold				9.797	0.669
<a href="#">675</a>	Calpine Corp. & Bechtel Enterprises Hold			18.285		
<a href="#">679</a>	Calpine Corp. & Bechtel Enterprises Hold	45.800				
<a href="#">680</a>	Calpine Corp. & Bechtel Enterprises Hold	4.400				

<a href="#">684</a>	<a href="#">Stapleton - Spence</a>	0.028	0.312	0.006	0.008	0.030	0.140
<a href="#">687</a>	Calpine Corp. & Bechtel Enterprises Hold	43.819	0.581				
<a href="#">688</a>	<a href="#">Calpine Corp. &amp; Bechtel Enterprises Hold</a>	52.270					
<a href="#">691</a>	Burns Philp Food Inc.	0.001					
<a href="#">696</a>	Siliconix; Incorporated					0.001	
<a href="#">697</a>	<a href="#">Calpine Corp. &amp; Bechtel Enterprises Hold</a>	85.863					
<a href="#">699</a>	Calpine Corporation		20.900				
<a href="#">704</a>	Enron North America Corp.	5.868					
<a href="#">708</a>	Exar Corporation					4.689	
<a href="#">709</a>	Enron North America Corp.	17.367					
<a href="#">710</a>	Midway Power, LLC	5.140					
<a href="#">712</a>	Enron North America Corp.	8.816					
<a href="#">713</a>	Enron North America Corp.	6.153					
<a href="#">714</a>	Enron North America Corp.	1.000					
<a href="#">716</a>	Calpine Corporation	0.200	11.660	0.040	1.130		0.670
<a href="#">718</a>	Midway Power, LLC	44.995					
<a href="#">719</a>	Midway Power, LLC	4.900					
<a href="#">720</a>	Midway Power, LLC		48.962				
<a href="#">722</a>	<a href="#">Catalytica Energy Systems Inc</a>	0.011					
<a href="#">723</a>	<a href="#">Catalytica Energy Systems Inc</a>		0.015		1.632		
<a href="#">724</a>	Calpine Corporation		7.100				
<a href="#">726</a>	New United Motor Manufacturing; Inc		0.343				
<a href="#">729</a>	Valero Refining Company - California	28.326					
<a href="#">730</a>	<a href="#">Del Monte Foods</a>	0.176	2.194	0.038	1.562		0.887
<a href="#">732</a>	Calpine Corporation	45.000					
<a href="#">734</a>	<a href="#">Catalytica Energy Systems Inc</a>				10.424		
<a href="#">735</a>	San Mateo Water Quality Control Plant	1.053	3.720	0.225	13.562		
<a href="#">740</a>	<a href="#">Pacific Gas and Electric Company</a>	9.790	32.680	1.070	12.930		13.530
<a href="#">741</a>	Calpine Corp. & Bechtel Enterprises Hold		96.813	436.470	54.340		
<a href="#">744</a>	Applied Biosystems	0.144	1.472	0.015	1.682		0.186
<a href="#">746</a>	Stauffer Management Company	0.700			9.100	0.400	0.700
<a href="#">748</a>	Zeneca; Inc.	0.200			0.200		
<a href="#">749</a>	Calpine Corporation		13.670				
<a href="#">750</a>	Calpine Construction Finance Co.;L.P.			4.120			
<a href="#">753</a>	Valero Refining Company - California	8.658					
<a href="#">756</a>	Mirant California	4.200	0.390	1.173	14.602		6.443
<a href="#">757</a>	Gaylord Container Corp.	0.135					

<a href="#">758</a>	Gilroy Foods, Inc.	0.203					
<a href="#">761</a>	Hanson Permanente Cement					2.852	
<a href="#">762</a>	Midway Power, LLC	38.993					
<a href="#">763</a>	<a href="#">Rexam Beverage Can Company</a>	13.083					
<a href="#">765</a>	Chevron Products Company		10.600	0.100	2.100		0.500
<a href="#">766</a>	Chevron Products Company	65.300					
<a href="#">767</a>	Midway Power, LLC	5.862	1.300				
<a href="#">769</a>	Amdahl Corporation					5.120	
<a href="#">770</a>	Dow Chemical Company	14.472					
<a href="#">773</a>	Midway Power, LLC		21.000				
<a href="#">774</a>	<a href="#">Conagra Energy Services; Inc.</a>				1.800		1.000
<a href="#">777</a>	Chevron Products Company	15.345					
<a href="#">778</a>	Midway Power, LLC	0.086	1.564	0.009	1.308	0.036	0.119
<a href="#">780</a>	Midway Power; LLC	2.880	4.960	0.030	4.880		0.390
<a href="#">782</a>	Owens Brockway Glass Containers	11.200			11.520		
<a href="#">785</a>	Philips Semiconductor					0.320	
<a href="#">786</a>	Calpine Corporation	0.017	1.026				
<a href="#">787</a>	<a href="#">Conagra Energy Services; Inc.</a>	61.138	2.070	0.024	1.161		0.538
<a href="#">788</a>	<a href="#">Gilroy Foods, Inc.</a>	0.422	7.653	0.046	6.439		0.583
<a href="#">789</a>	Calpine Corporation	15.856					
<a href="#">793</a>	Amdahl Corporation					11.818	
<a href="#">798</a>	Midway Power, LLC	0.148	2.691	0.016	2.261		0.205
<a href="#">800</a>	Midway Power; LLC						1.197
<a href="#">812</a>	Martinez Refining Company	19.400	13.800	0.100			
<a href="#">813</a>	<a href="#">Ball Metal Beverage Container Corporation</a>	8.692	3.571	0.021	2.999		0.271
<a href="#">819</a>	USS-POSCO Industries	3.000	5.011	0.290	4.910		0.360
<a href="#">821</a>	Waste Management of Alameda County						98.010
<a href="#">822</a>	Calpine Corporation	1.029					
<a href="#">823</a>	Crown Cork & Seal Company	71.000					
<a href="#">824</a>	Crown Cork & Seal Company	4.500					
<a href="#">827</a>	Tesoro Refining and Marketing Company	1.045					
<a href="#">830</a>	Midway Power, LLC		171.000				
<a href="#">831</a>	Mirant California	72.280	66.060		450.600		202.530
<a href="#">832</a>	BP West Coast Products, LLC	0.578					
<a href="#">833</a>	Valero Refining Company - California	80.000					
<a href="#">837</a>	Valero Refining Company - California						3.463
<a href="#">839</a>	Tesoro Refining & Marketing Company	0.319					

<a href="#">835</a>	Calpine Corp. & Bechtel Enterprises Hold	0.210		0.030	1.650	
<a href="#">840</a>	Calpine Corporation			0.090	2.610	
<a href="#">841</a>	Calpine Corp. & Bechtel Enterprises Hold	46.930				
<a href="#">842</a>	<a href="#">Fleischmann's Yeast</a>	11.120				
<a href="#">843</a>	Pacific Custom Materials, Inc.	1.127	17.786	22.635	17.779	3.069
<a href="#">844</a>	<a href="#">Homestake Mining Company</a>					1.222
<a href="#">846</a>	<a href="#">Fleischmann's Yeast</a>	0.106	0.670	0.012	0.569	0.147
<a href="#">847</a>	Shell Chemical LP	6.590				
<a href="#">848</a>	<a href="#">Myers Container Corporation</a>	20.030			7.390	
<a href="#">849</a>	<a href="#">Myers Container Corporation</a>	10.787	0.559		0.112	4.850
<a href="#">850</a>	<a href="#">Norcal Waste Systems</a>	0.077	8.312	0.418	0.155	0.173
<a href="#">852</a>	Shore Terminals - Selby	8.450	11.352			
<a href="#">854</a>	<a href="#">Myers Container Corporation</a>		0.316	0.002	0.265	0.024
<a href="#">856</a>	Calpine Corporation	26.522				
<a href="#">805</a>	United Airlines	33.285				
<a href="#">858</a>	Midway Power, LLC	2.353				0.094
<a href="#">859</a>	<a href="#">C &amp; H Sugar Company, Inc</a>				37.282	
<a href="#">860</a>	City of Santa Clara dba Silicon Valley Power	5.000				
<a href="#">861</a>	City of Santa Clara dba Silicon Valley Power		51.500			
<a href="#">862</a>	Conoco Phillips			3.500		
<a href="#">863</a>	Mirant California	5.300	247.500	130.179	114.000	25.270
<a href="#">865</a>	City of Santa Clara dba Silicon Valley Power	6.500				
<a href="#">867</a>	Chevron Products Company	1.573				
<a href="#">870</a>	<a href="#">Burns Philp Food, Inc.</a>	16.259				
<a href="#">871</a>	<a href="#">LSI Logic Corporation</a>	3.904			0.195	
<a href="#">873</a>	<a href="#">Johns Manville Roofing Systems Group</a>	1.074				
<a href="#">875</a>	<a href="#">Cunningham Graphics a Subdiary of ADP</a>	4.704				
<a href="#">876</a>	ConocoPhillips	76.860				
<a href="#">878</a>	<a href="#">Johns Manville Roofing Systems Group</a>	5.474				0.308
<a href="#">879</a>	BP West Coast Products, LLC	0.787				
<a href="#">880</a>	Intel Corporation		28.130			
<a href="#">882</a>	Valero Refining Company - California	5.987				
<a href="#">883</a>	Valero Refining Company - California			2.687		
<a href="#">884</a>	Martinez Refining Company	2.980				
<a href="#">885</a>	<a href="#">Johns Manville Roofing Systems Group</a>	1.521				
<a href="#">886</a>	<a href="#">Johns Manville Roofing Systems Group</a>	0.026	1.990	6.514	0.019	0.491
<a href="#">887</a>	Chevron Products Company	39.777	36.225	133.812	485.471	31.134

<a href="#">889</a>	<a href="#">United States Pipe &amp; Foundry Company</a>	23.400					
<a href="#">893</a>	Tesoro Refining & Marketing Company	7.080					
<a href="#">894</a>	United Airlines	45.000					
<a href="#">895</a>	<a href="#">Calpine Corp. &amp; Bechtel Enterprises Hold</a>	80.325	49.864	1.030	33.320	7.265	
<a href="#">896</a>	<a href="#">Calpine Corp. &amp; Bechtel Enterprises Hold</a>		405.205	90.000	33.000	20.500	
<a href="#">897</a>	Owens Corning	1.995	39.800		32.600	6.100	
<a href="#">898</a>	Lesaffre Yeast Corporation	35.620					
<a href="#">899</a>	SFPP; LP	2.178					
<a href="#">900</a>	Chevron Products Company		1.027	0.060	0.537	0.312	
<a href="#">901</a>	Chevron Products Company	6.463					
<a href="#">902</a>	Tesoro Refining & Marketing Company	4.829					
<a href="#">903</a>	Ball Corporation	0.301					
<a href="#">904</a>	Chevron Products Company	1.755	5.040	0.050	1.000	0.250	
<a href="#">905</a>	Waste Management of Alameda County	0.716					
<a href="#">906</a>	<a href="#">Johns Manville Roofing Systems Group</a>					0.043	
<a href="#">907</a>	<a href="#">Johns Manville Roofing Systems Group</a>	1.399					
<a href="#">908</a>	<a href="#">Johns Manville Roofing Systems Group</a>	10.381					
<a href="#">909</a>	<a href="#">Johns Manville Roofing Systems Group</a>					0.390	
<a href="#">910</a>	<a href="#">Johns Manville Roofing Systems Group</a>					0.005	
<a href="#">911</a>	<a href="#">Johns Manville Roofing Systems Group</a>					0.325	
<a href="#">912</a>	<a href="#">Johns Manville Roofing Systems Group</a>	0.099				0.325	
<a href="#">913</a>	Pacific Custom Materials, Inc.					2.030	
<a href="#">914</a>	Valero Refining Company - California			5.068		0.037	
<a href="#">915</a>	Tesoro Refining & Marketing Company		9.671	4.584	2.938	0.327	
		<b>140</b>	<b>4023</b>	<b>2473</b>	<b>1206</b>	<b>1708</b>	<b>459</b>
						<b>527</b>	

APPENDIX 8.1G

## Protocol for a Cumulative Impacts Analysis for the SFERP Facility

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## APPENDIX 8.1G

### PROTOCOL FOR A CUMULATIVE IMPACTS ANALYSIS FOR THE SFERP FACILITY

Potential cumulative air quality impacts that might be expected to occur resulting from the construction and operation of the SFERP and other reasonably foreseeable projects are both regional and localized in nature. These cumulative impacts will be evaluated as follows.

Cumulative impacts from the SFERP could result from emissions of carbon monoxide, oxides of nitrogen, sulfur oxides, and directly emitted PM<sub>10</sub>. To ensure that other projects that might have significant cumulative impacts in conjunction with the SFERP are identified, a search area with a radius of 6 km will be used for the cumulative impacts analysis.

Within this search area, three categories of projects with combustion sources will be used as criteria for identification:

- Projects that are existing and have been in operation since at least 2002.
- Projects for which air pollution permits to construct have been issued and that began operation after 2002.
- Projects for which air pollution permits to construct have not been issued, but that are reasonably foreseeable.

Projects that are existing and have been in operation since at least 2002 are already reflected in the ambient air quality data that has been used to represent background concentrations; consequently, no further analysis of the emissions from this category of facilities will be performed. The cumulative impacts analysis adds the modeled impacts of selected facilities to the maximum measured background air quality levels, thus ensuring that these existing projects are taken into account.

Projects for which air pollution permits to construct have been issued but that were not operational by 2002 will be identified through a request of permit records from the Bay Area AQMD. The search has been requested to be performed at two levels. Projects that had a permit to construct issued after January 1, 2000, will be included in the cumulative air quality impacts analysis. The January 1, 2000 date was selected based on the typical length of time a permit to construct is valid and typical project construction times, to ensure that projects that are not reflected in the 2002 ambient air quality data are included in the analysis. Projects for which the emissions change was smaller than 10 pounds per day will be assumed to be *de minimis*, and will not be included in the dispersion modeling analysis.

A list of projects within the area for which air pollution permits to construct have not yet been issued, but that are reasonably foreseeable, has also been requested from the BAAQMD staff.